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Raising Motivation in Secondary School Students

Can contextualising mathematic concepts in real world situations improve learning? A preliminary study

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Chapter 1: ABSTRACT

This study is a preliminary investigation into whether secondary school students can be motivated by the introduction of material into their maths curriculum which contains skills which are specifically needed for future life and work.

The research takes place in a secondary school where motivation is very mixed. The students are divided into a target and a control group, giving one an adapted curriculum where skills for future life and work are specifically included while the other studies a more traditional academic curriculum. The groups study for three weeks and are then reversed so that the target becomes the control for the next topic. Both groups are given a common assessment task and an open-ended task for homework for each topic.

The class is evaluated on: attendance, completion of the open-ended tasks, attitude to learning (questionnaires about the learning in the specific topics) and their topic assessment. Each student also completes an attitude questionnaire and is interviewed at the end of each topic. The teachers are also interviewed and the classes observed by an impartial observer on two occasions.

The results indicate some evidence of improved performance in the class with the adapted curriculum in: attendance, assessment (number of questions attempted and number of correct answers), attitude to learning (only slight evidence), quality and independence of classwork and quality and quantity of homework. There was, however, no long-term benefit across the subject as a whole in terms of academic achievement. The students were able to identify the value of some of the maths skills for future life and work but the identifying of such skills did necessarily lead to better performance in these topics. There were no student groups which were specifically identified as being influenced to a greater or lesser extent by the change in curriculum.

Chapter 2: INTRODUCTION

Secondary schools are under constant pressure to raise academic standards. Examples include *The importance of teaching* HM Government White Paper 2010 and OFSTED's *School Inspection Handbook*, August 2015 which Ofsted states that inspectors "will take a range of evidence into account when making judgements, including published performance data, the school's in-year performance information….".

Exam results are analysed and scrutinised with the very future of the school dependent on consistently good levels of academic achievement in the students. There is a constant drive to raise these standards and any factor which may influence the outcomes is investigated and debated.

At the same time, there is a drive to turn all schools into academies. These schools are nominally independent within the state system – fully funded by the state but independent of local authority control. While operating under the same regulatory and accountability frameworks, including common assessments at the age of 16 and 18, there is a valuable opportunity to vary the curriculum. The implication is significant: should schools discover way in which they can enhance student performance by varying the curriculum, methodology or structure, they are at liberty to adopt it.

At the heart of this study is the proposal that motivation in secondary school students is a highly significant factor in their engagement with their work and, consequently, their success. This is the theory put forward by the author of this study.

There will be schools where the vast majority of students are motivated either by their own background and that of others securing places at the school or a very strict school disciplinary system. For example "A person's motivation …… is also nurtured by the prevailing culture" (Bogomolny).

There are other schools, however, which have teaching, facilities and curriculum which are all good and students who have a comparable level of intrinsic ability and yet achieve a lower level of academic success. It is suggested that the missing factors, which prevent these students from achieving their potential, are those of motivation. It is hoped to be able to show that, were the school able to raise the motivation of all students to a high level, it would be able to achieve proportionally better results.

The literature review in this study looks at the factors within the students' learning experience which have been found either to motivate or de-motivate them to engage with their work. This experimental part of this study attempts to establish if altering the curriculum (by providing direct references to the value of the material studied in future life and work) may motivate students to learn.

The literature review considers a range of theories of motivation, how they have been applied in a school situation, how different factors impact on motivation and what the results can be. In

particular, the review considers goal theory and compares the mastery goal mindset[1] with the performance goal mindset.

In the published literature, there are studies which describe "relevance" and "usefulness" of the material being taught as being factors which tend to increase motivation in students. Many schools also have extensive careers guidance and information about which jobs and university courses require which academic qualifications; however, this information is not provided as a way to motivate students or in any way to validate their learning experience – it is purely information provided to help in planning future work and study.

There have, therefore, been no studies found which specifically consider the role of work-place and other practical skills within the mainstream academic curriculum as a motivating or validating factor. The theory which is to be tested within this study is whether explicitly teaching the skills which are needed for future work or careers would in itself provide the motivation for students to engage better and, hence, perform better at school.

The researcher conducts a case study in a secondary school (with a very mixed level of achievement, which, it is proposed, may stem from mixed levels of motivation). This case study divides the cohort into a target and a control group, teaching the target group an "adapted" mathematics curriculum which makes explicit the practical skills being taught. The two groups are swapped around for a second block of work. A range of data is collected including academic performance (on a range of measures), student opinion, behaviour and attendance, as well as the teachers' opinion of the way the students engaged with the work. The detail of this work appears in the section *Research Design*.

In considering the general question of whether this adapted curriculum was able to increase motivation, the study considers questions whether some students were affected more than others and if there was a reason or a pattern for this.

The results are analysed from which some conclusions were drawn, followed by suggestions for additional research in this area.

At the outset, it is important to note that the author and researcher is a career teacher (mathematics) with 23 years of experience in secondary schools in UK and abroad. The reason for undertaking this research is an attempt to unlock the reasons why students in some schools do so much better than those of comparable ability in other schools. The starting point for the research is the opinion that much of this variation is due to motivation and this study attempts to enhance motivation by varying one aspect of the curriculum. The experimental aspects of this study are conducted by the researcher, working closely with two teaching colleagues and their classes; the curriculum is written by the researcher who also conducts the interviews and on a few occasions teaches the classes.

The remaining chapters of this study are:

Chapter 3, the literature review, which considers existing studies into the factors which motivate students to learn and achieve.

[1] A "mindset" is defined as "a person's way of thinking and their opinions" (Cambridge English Dictionary). In the context of educational psychology, the most common reference to mindset is by Carole Dweck who distinguishes between *fixed* and *growth* mindsets (Dweck 1986).

Chapter 4 outlines the aims of the study in detail and the gaps in existing studies which it is hope that this study will help to fill, and Chapter 5 considers the methodology.

Chapter 6 contains the detailed research design with Chapter 7 looking at positionality, ethical considerations (since this study is working with children) and the limitations of the research and chapter 8 identifying the data to be collected in the course of the experiment.

Chapter 9 considers the results from the data and conclusions are drawn in chapter 10.

Chapter 3: LITERATURE REVIEW

Introduction

This chapter begins with a review of some of the fundamental theories of motivation such as self-efficacy theory, attribution theory and self-worth theory. Studies are reviewed which demonstrate factors within the classroom or the curriculum which trigger such motivations and how these motivations may translate into better performance. The studies which were considered were, in the first instance, the most widely used and quoted in the general field of the psychology of motivation and, in the second instance, the ones most closely aligned with the core purpose of this study, namely the motivation of students in secondary school.

The study considers goal theory, comparing mastery with performance goals. There are two reasons why goal theory is considered to be relevant to this study. The first is that schools, pupils and teachers are, in recent years, "measured" by targets and the extent to which these outcomes are met – these fall neatly into the definition of performance goals. The attempt to engage and garner the interest of students in their study is the creation of mastery goals, which might also be presumed to be an intended purpose of schools. The inter-relation of these two goal types is interesting, as is the range of activities which might serve to enhance either or both of these goals. When considering external factors which might impact on goals, it is important to understand which of these goals might be more affected.

Studies are considered which demonstrate which factors of the school learning experience may promote each of these goals and how the adoption of the mindsets associated with each of these goals may result in higher motivation, better engagement with school work and, hence, higher levels of achievement.

Under consideration are methods of teaching, selection of material, organisation of students, physical classroom attributes and feedback; each of these can enhance or diminish this motivation.

Specifically, this study is seeking to discover whether, when the material being taught specifically includes the application of mathematical skills in the future work-place or real life, this is more highly valued by students. The implication is that, were it to be more highly valued, this would be demonstrated by a) students explicitly stating that they valued it, or b) their better engagement in lessons, and c) their spending more time and effort on the tasks, and hence d) their higher performance in the quality of their work (as measured in a range of ways).

The review has not discovered studies which specifically measure this aspect of teaching and learning. However, there are a number of features of lessons which could include interest, relevance and usefulness. These aspects could all include the value of learning skills for the future work-place. This review also considers whether the teaching of skills relevant to the work-place tend to promote goals which are either mastery or performance. It considers whether the promotion of these mindsets for these two types of goals are deliberate or beneficial.

Theories of motivation

The major studies on motivation which appear in the existing literature consist of the theoretical positions of self-efficacy, attribution, self-worth and achievement goal theory (Seifert, 2004). While

the studies which lead to these theories are not specific to student or child motivation, in the absence of specific child-related motivation theories, these are relevant starting points.

Seifert (2004) identifies the four theories of motivation prominent in contemporary educational psychology mentioned above, suggesting that, while each may be presented on its own, there are clearly inter-relationships.

Self-efficacy theory is a student's belief in his or her ability to complete tasks. A construct of self-confidence, self-efficacy is linked to performance of specific tasks at specific levels; in other words, the belief that the particular task at hand either can or cannot be achieved. This belief may be drawn from past academic performance and will probably be linked to an opinion of self-worth. Self-efficacy may in turn lead to greater motivation and a particular choice of activities (Bandura, 1977, 1993). Conversely, students who perceive themselves to be non-efficacious may avoid tasks that they see as challenging or difficult, while those who are highly efficacious will be more willing to face difficult or challenging problems (Schunk, 1984, 1985; Bandura, 1993). Students with high self-belief are more likely to display adaptive, mastery behaviours, while those without this self-efficacy are likely to display performance-oriented behaviours which support the ego (Dweck, 1986).

Where self-efficacy theory may be incomplete is that, while students who believe themselves to be incapable of achievement will not be motivated to learn, the reverse may not be true – that students who are not motivated must be incapable. They may be 'bright and bored', for example, (Seifert, 2004). There may be other students, who, while recognising that the task in hand is beyond their immediate capacity, may attempt it anyway, either as a challenge or they may protect themselves from failure in advance by announcing their inability to complete the task before failing.

Another potential weakness of self-efficacy theory may be that there is an underlying presumption that students wish to succeed, or are motivated to do so. A student who does not see any point in completing a task (whether or not they believe they *can* complete it) and is not interested in the rewards associated with success in that task, may not even get as far as evaluating their own ability. They may simply not engage and it is this non-engagement which might protect their ego.

Attribution theory refers to students' belief in the cause of a particular event or outcome. These may involve events outside the students' control such as luck or the whim or a teacher, but may also include effort, skills, knowledge and strategies. Where a student attributes this to fixed knowledge (such as: I am good at this task / subject) the behaviours which result will be different to when it is attributed to something within the student's control such as effort or strategy. Dweck (1986) suggests that intelligence is dynamic rather than static and can be developed. Where students share that belief, their behaviour will be different from where performance is attributed to a factor beyond their control, which would be the case if intelligence were fixed.

The use of tasks which build in difficulty may help to convince students' of the Dweck view-point. Feedback which stresses progress over time will serve to change students' perception of their own ability. This will particularly be the case if students review their own progress and can see improvement.

Seifert himself recognises the inter-relationships between the different theories of motivation – the link between attribution and self-efficacy theories clearly relates to Dweck's studies of the perception of fixed and dynamic ability. However, again, this does not take into account the student who simply has no interest in the task. While there may be categories of students who a) do not

believe they can complete a task and b) root this belief in causes which are beyond their control, there are others who c) do not see the point in even attempting it. Were the value of the task to be better understood, the severely de-motivated student might engage at least to the extent of establishing whether or not they could achieve success *should they so wish*.

Attribution theory does not contradict self-efficacy theory but neither does it support it. While self-efficacy theory is the student's belief in his or her ability to complete a task, attribution provides the student with a reason *why* they can or cannot complete the task, fixing it either within or beyond the student's control.

Self worth theory of motivation is that a person's value or worth depends on their ability to do a particular task (eg achieve good grades) well (Covington, 1984). This is generally a Western cultural belief. This allows students in a classroom to come to a conclusion on their actual self-worth based on their academic performance. The resulting behaviours from this belief lead to a very risk-averse attitude to task choice. Covington's research is based on study and learning rather than efficacy in the work-place. Were the studies to investigate adults in a work environment (Baumeister et al, 2003) it might be possible to establish whether building skills which may be useful in later work and life might build self-worth now.

Goal theory

Locke (1968) proposed a theory which postulated that performance was not caused directly by the presence of incentives such as the knowledge of the results of the intended task. Instead, he suggests it is determined by the worker's interpretation and evaluation of the incentives – leading to aspirational goals. These goal aspirations are what determines task performance (Chacko and McElroy, 1983).

Ames 1992 describes an achievement goal framework which integrates cognitive and affective components of goal-directed behaviour. Elliott and Dweck (1988) describe achievement goals as using a programme of cognitive processes which have 'cognitive, affective and behavioural consequences'.

Andeman (1997) states that "goal orientation theory examines the reasons why students engage in their academic work."

It therefore appears that a substantial number of existing studies relate educational motivation to goal theory. They distinguish between the two categories of goals (see below), and suggest how various structures within schools, classrooms and lessons create the climate where students are influenced by these goals and are hence more or less motivated to achieve in their studies.

Mastery and performance goals

The concept of a "goal" has been divided into two separate constructs, the differentiation being the processes of motivation, and the difference between the two has implications in the design of student tasks and classroom design. The two have been differentiated in several ways. **Learning** and **performance goals** (Dweck 1986, Dweck and Leggett, 1988, Elliott and Dweck, 1988), **task-involvement** and **ego-involvement** goals (Maehr and Nicholls, 1984) and **mastery** and **performance goals** (Ames and Archer, 1987). Ames' notation (mastery and performance) will be referred to for simplicity.

Mastery goals and performance goals differ in:

- the motivation for attempting a task
- the view a student has of him or herself
- the view a student has of the task and what its successful outcome looks like

The Mastery Goal mindset has the following attributes:

1 A set of beliefs, linking to
2 A philosophy of learning, leading to
3 Implications for the way the students learn

The set of beliefs:

- The successful outcome is dependent on effort (Dweck, 1986).
  Ames (1992) states that, when the goal is mastery, the student believes that effort will lead to mastery in the task. Importantly, in a classroom situation, students pursuing these goals believe that there are factors *within their own control* (such as effort) which may lead to success; the corollary of this belief is that intelligence or ability is not fixed (Dweck & Leggett, 1988).
- A sense of belonging is said to relate to the mastery mindset (Weiner, 1990) so that when a student feels that they belong in a learning environment, they relate their own self-perception to that of the task being undertaken and others who are involved with the venture. When mastery goals are adopted, pride and satisfaction are associated with successful effort (Jagacinski & Nicholls, 1984, 1987).

The philosophy of learning:

- The focus of the student's effort is on the intrinsic value of the learning (Butler, 1987). With this mindset, students will strive to develop ("master") new skills, try to find understanding in their work and will reference their standards of achievement to their own prior performance in order to demonstrate progress (Brophy, 1983). Brophy links this with a motivation to learn, fully engaging in the process, to understand concepts and master skills; referred to as 'effort-outcome perception' (Ames 1984). A question arises whether this is solely a feature of mastery mindset or whether, in fact, the striving to develop new skills may be equally applicable to performance mindset.

Implications for learning:

- Importantly, in a school setting, mastery goals increase the amount of time children spend on learning tasks (Butler, 1987) and the effort displayed in attempting to overcome difficulties (Elliott and Dweck, 1988). Furthermore, the quality of engagement in learning activities is increased, examples being strategies for solving problems and the willingness to adapt these strategies in the face of temporary failure (Garner 1990). This focus has been recognised as likely to lead to certain types of developmental question such as "How can I understand this?" (Nicholls, 1984), "How can I master this task?" (Elliott and Dweck) or "How can I do this?" (Ames).
- As above, there is nothing in these strategies which is fundamentally limited to a mastery mindset. In order to achieve performance goals, a student may equally engage more

fully, develop resilience in the face of set-backs and seek opportunities to build understanding.

- Weiner (1979) suggests that a mastery mindset causes behaviour to be directed towards achievement over a more extended time period, although it is not clear exactly what this time frame is nor is it clear whether this necessarily makes for more effective learning.
- Seifert (1997) suggests that students who pursue these may be described as self-regulating and self-determining. Pursuit of these learning goals may lead to cognitive development (or learning!). Since strategies for self-regulation and strategic thinking contribute highly to students' performance on many school tasks, the mastery goal is particularly important (Covington, 1985).
- Mastery goals have also been associated with a preference for challenging work and risk taking (Ames & Archer, 1988; Elliott & Dweck, 1988), an intrinsic interest in learning activities (Butler, 1987; Meece et al., 1988; Stipek & Kowalski, 1989), and positive attitudes toward learning (Ames & Archer, 1988; Meece et al., 1988).

The Performance Goal mindset is characterised by:

Beliefs:

- A self-perception which is based on how they are regarded by and compared to others (Dweck, 1986) and this is closely linked to a sense of self-worth. A goal is believed to have been achieved when there is public recognition of it, in comparison with other students, and this will be attributed to ability rather than effort. Covington and Beery (1976) point out that this belief links a student's perception of their own worth to their ability to perform the given task. When a performance goal mindset is adopted, a student's opinion of his own ability becomes an important determinant of his behaviours (Dweck, 1986). Since performance is judged (by himself) in comparison with norms based on others, students with low self-concept of ability are less likely to choose challenging tasks (Dweck, 1986; Pintrich & De Groot, 1990; Dweck & Leggett, 1988; Elliott & Dweck, 1988). The pursuit of performance goals may be seen as an attempt to protect ego, and as such may avoid tasks which are likely to lead to failure. This is sometimes known as "learned helplessness" (Covington, 1984; Jarvis & Seifert, 2002; Diener & Dweck, 1978).
- A belief in a *fixed ability* which can be demonstrated by performance (Covington 1984, Dweck 1986, Nicholls 1984). Where effort is expended and there is the possibility of failure, it breaks the link with ability and consequently damages the ego (Covington and Omelich, 1979). Effort is therefore not associated so much with this mindset.

Implications for learning:

- A belief that learning is only a means to achieve a particular goal (Nichols, 1984).
- A desire for students to seek achievement with minimum effort – Ames (1984); Covington (1984); Jagacinski & Nicholls (1987).
- Students being more likely to place the cause of success or failure outside the zone of their own control, mostly putting it down to fixed ability or intelligence (Dweck & Leggett, 1988). There is a negative view that failure is accompanied by the judgement that the student lacks ability. This encourages the use of superficial or short-term learning strategies, such as memorizing and rehearsing (Meece et al., 1988; Nolen, 1988; Ryan & Grolnick, 1986).

It is clear from the above comparisons that the mastery goal orientation is likely to promote a motivational pattern which is likely to lead to long-term, high-quality learning (Ames, 1992), and it is therefore significant in the design of tasks, learning activities, evaluation, reward, responsibilities and procedures in the classroom.

Seifert argues that students' perception of their own competence and their idea of cause and effect ("agency") are central to the understanding of their motivation and have a significant impact on their behaviour. The student who is confident in both his ability and his control over the task, perceives value in the task and has a sense of agency is most likely to pursue goals of learning and mastery (Seifert 2004). Dweck (1986) describes this as a 'mastery goal-pursuit pattern' and Covington (1984) describes 'success orientation' or 'intrinsic motivation'.

There is a question whether securing long-term in-depth learning is always a) feasible b) valuable or c) detrimental to more short-term, performance-goal-related learning. There will be a class of students who, by their nature, take little interest in learning for its own sake, show little curiosity and need to have a concrete reason for a piece of study. In a secondary school with students of compulsory school age, this is by no means rare, and schools need to achieve success for these students. While they may never be destined for university, nor would this be desirable in many cases, there is no reason why they cannot attain success in school tasks and receive appropriate accreditation. In this study, it may be that performance goals are central to the motivation engendered in students, and it is expected that under *some* circumstances this will inspire students to learn more deeply, hence adopting more of a mastery mindset.

Competitive, co-operative and individualised goals

Ames (1984) further divides goals into competitive (ability-evaluative), co-operative (moral responsibility) and individualised (task mastery).

Co-operative The chances of a student being successful is enhanced by the presence of other successful students around them.

Competitive Each student is competing for the best grades and where outcome necessarily depends on the position or rank within the class. In such a competitive structure, motivation solely depends on relative performance.

Individual This involves the virtual fusing of the person with the demands of task. Participation in the task therefore becomes the goal itself. (Veroff 1980) In this structure, success does not depend on the failure (or success) of others and this implies that effort is the route to success – "if I try, I can".

It is important to note here that Johnson (Johnson et al 1981) reviewed these different structures (individual, competitive, cooperative) and discovered that in studies fewer than 10% mentioned motivation as a moderating variable. He found that in most cases motivation was just discussed as a co-variate of achievement in that outcome *presumes* motivation.

Summary

There are five widely-accepted theories of motivation: self-efficacy theory (Dweck, Schunk, Bandura) concerning the students' belief in their ability to complete tasks, attribution theory (Dweck, Seifert) concerning students' belief in the ultimate cause of their success, self-worth theory

(Covington) concerning students' belief that their own value is dictated by their ability to perform and mastery and performance goal theories. None of these theories give specific actions which can promote motivation; however, they do lay a foundation upon which other theories are based. These theories are to some extent the application of the basic theories.

Strategies for the classroom and impact of motivation theories

In 1997 Brophy posed the question what the difference was between intrinsic motivation (of a task) and the motivation to learn. In doing so, he questioned whether some strategies just stimulated motivation to do the tasks rather than to learn.

However, seven years later he defines motivation to learn as 'a student's tendency to find academic activities meaningful and worthwhile and to try to get the intended learning benefits from them.' (Brophy, 2004). In *Synthesis of Research on Strategies for Motivating Students to Learn* (2007) he highlights the following strategies:

Highlights of Research on Strategies for Motivating Students to Learn

Research on student motivation to learn indicates promising principles suitable for application in classrooms, summarized here for quick reference.

Essential Preconditions
1. Supportive environment
2. Appropriate level of challenge/difficulty
3. Meaningful learning objectives
4. Moderation/optimal use

Motivating by Maintaining Success Expectations
5. Program for success
6. Teach goal setting, performance appraisal, and self-reinforcement
7. Help students to recognize linkages between effort and outcome
8. Provide remedial socialization

Motivating by Supplying Extrinsic Incentives
9. Offer rewards for good (or improved) performance
10. Structure appropriate competition
11. Call attention to the instrumental value of academic activities

Motivating by Capitalizing on Students' Intrinsic Motivation
12. Adapt tasks to students' interests
13. Include novelty/variety elements
14. Allow opportunities to make choices or autonomous decisions
15. Provide opportunities for students to respond actively
16. Provide immediate feedback to student responses
17. Allow students to create finished products
18. Include fantasy or simulation elements
19. Incorporate game-like features
20. Include higher-level objectives and divergent questions
21. Provide opportunities to interact with peers

Stimulating Student Motivation to Learn
22. Model interest in learning and motivation to learn
23. Communicate desirable expectations and attributions about students' motivation to learn
24. Minimize students' performance anxiety during learning activities
25. Project intensity
26. Project enthusiasm
27. Induce task interest or appreciation
28. Induce curiosity or suspense
29. Induce dissonance or cognitive conflict
30. Make abstract content more personal, concrete, or familiar
31. Induce students to generate their own motivation to learn
32. State learning objectives and provide advance organizers
33. Model task-related thinking and problem solving

—Jere Brophy

For the purposes of this study, it is important to note the following strategies which are most relevant:

Strategy number 11: Call attention to the instrumental value of academic activities. This tells students that this piece of learning is their ticket to social advancement, or to prepare them for success in their job or life.

Strategy no 27: Induce task interest or appreciation – in this case because it may be useful in later work.

Strategy no 33: Task-related thinking and problem solving.

Motivation will manifest itself in several ways:

- Better engagement with the tasks, more time on task, the likelihood of better organisation of work. This will itself lead to better academic outcomes.
- Desire to understand more - thirst for knowledge, which will push for further or deeper study which leads to better academic outcomes.

Carole Ames (1992) suggests that particular classroom structures influence the goals which students choose to adopt. Importantly, she specified how dimensions of tasks, evaluation, and authority influence whether students perceive the classroom as oriented toward mastery goals, which in turn affects the quality of students' engagement in learning.

Making the assumption that a teacher wishes to maximise the time students devote to a learning task, the quality of their engagement and the desire for deeper learning, the teacher needs to design tasks which promotes the mastery goal mindset, and much of the literature adopts this position. However there should be no reason to regard success in a range of tasks which lead to specific and limited skills to be less valid for certain students. These skills could be vocational in their nature, or they could be more academic but less complex. There is a 'putative utopia' which is inferred in the results of some of these studies: this is the position where all students reach the state of wishing to pursue academic study in increasing depth just for its own sake. It is suggested that this is a rather narrow view of what success in school looks like.

A range of factors which aid the endeavour of promoting higher quality engagement and deeper learning can be grouped as follows:

1 The organisation of the work
2 Students' attitude to the work

The organisation of the work

Variety and diversity of tasks

Tasks which contain variety and diversity are more likely to raise the interest in students and hence a mastery goal (Marshall and Weinstein 1984). There are many ways to create variety, such as through games, use of imagination, competitions, and co-operative learning. However, Blumenfeld, 1992, warns that more knowledge is needed about which types of variety promote the mastery orientation and which types simply garner short-term attention. It is possible for variety to detract from a focus on the real content, hence not sustaining motivation to learn in the long-term. Students may focus on the method or novelty rather than the learning or problem to be solved. Similarly, where social interaction is an integral part of the learning experience (group work), those less suited to this form of learning may be inhibited from learning.

Appropriate challenge (Malone and Lepper, 1987, Doyle, 1983 and 1986)

It is important that tasks are challenging enough, and those which do contain challenge are more likely to promote the mastery orientation (Malone and Lepper, 1987).

At the other end of the scale, students may also avoid work if they feel able to do it but find little challenge, reason, stimulation or satisfaction in its completion (Seifert, 2004).

There is, therefore, clearly a balance to be struck between providing a good level of challenge for students and setting a task which may not allow a good chance for success and this will involve careful matching of tasks to particular groups of students.

What is not mentioned in these theories is the group of students who are satisfied with achieving a level of skills sufficient to complete a given task but do not relish further challenge.

Evaluation and feedback (Blumenfeld, 1992, Brophy, 1987, Ames and Archer, 1988)

Blumenfeld suggests that the method of evaluating or grading a student's work may impact on their mindset. Where grades stress correct answers, particularly when these grades are easily compared with one another, this is likely to lead to a performance goal mindset and can be seen as controlling. However, if the grades are accompanied by the opportunity for improvement, a growth mindset may be encouraged. Where others in the class are perceived as competitors (this will particularly be the case when rankings are used, but will also occur when absolute performance grades are awarded, and there is public awareness of these marks) there will the perception that the class promotes performance goals, whereas if the impact of others on a personal grade is minimised, mastery will be promoted.

The underlying of this premise is questioned in two ways: Firstly, are students so inquisitive as to wonder whether mastery or performance goals are being promoted? Does the position in a rank really encourage short-term learning and discourage long-term, deeper study? Secondly, this relies on the proposition that all students are actively interested in their grades – whether absolute, progressive or relative. There will be others who are simply satisfied to know that they have achieved a certain skill – and this mindset will be all the easier to achieve if the value of that skill is based on real-life experience.

Brophy lists immediate feedback to student responses and opportunities for students to respond actively as key elements for increasing motivation.

Even when students perceive a particular class as promoting mastery goals, they may still reduce the effort expended on long-term tasks if they do not see consequences for poor performance. This may lead to more effort being applied in classes with a performance orientation owing to the fear of poor evaluation – even if the quality of cognitive engagement is lower.

Group-work (Ames and Ames, 1984, Ames, 1981, Slavin, 1983, Sharan, 1980)

Ames and Ames (1984) look at co-operative structures and suggest that morale rather than ability concerns underlie motivation. In situations where there is an inter-dependency, students will assist others and feel responsibility towards the group, share resources, results, etc. One positive result of this is that effort is given in order to further the causes of the whole group.

In co-operative or group situations, it is group outcomes, rather than personal ones, which affect students' self-perception of success. However, one negative effect is that, if the group task is unsuccessful, individuals are liable to be blamed if the failure is thought to be due to their lack of effort. Ames suggests that, in these situations, those on the receiving end of the blame might attribute their lack of contribution to their own lack of ability rather than effort. It is, however, pointed out that the research in question stressed absolute performance outcomes rather the progress. Slavin posits that group or co-operative working can improve performance more when rewards are given for group improvement rather than absolute scores. Sharan (1980) points out that group solutions are often better than those generated by individuals, hence providing a greater degree of success which in turn motivates those who have achieved it.

Rewards (Brophy, 2004)

Brophy discusses the difference between extrinsic and intrinsic rewards in education, offering suggestions about how to make the curriculum more intrinsically rewarding to students. He suggests that by focusing on student autonomy and competence, emphasizing the relevance of subjects, students will find satisfaction in learning for its own sake. This is particularly apparent, he says, in project-based or open-ended learning. Conversely, he notes that extrinsic incentives can be effective at times. However, in the long run there may be limits to their effectiveness and they undermine the value placed on learning per se, suggesting that the primary motivation should be understanding rather than external rewards.

Students' attitude to the work

Likely success (Wolters, 2004, Brophy, 2004 and 2007, Schunk, 1984)

Wolters investigated how different components of achievement goal theory were related to each other and to students' motivation, cognitive engagement, and achievement in mathematics. The results indicate that mastery structure and mastery orientation were related to all outcomes, creating adaptive behaviours in all cases. He has not, however, concluded that the link between aspects of achievement goal theory and student achievement is a clear and positive one, especially in younger students. Schunk suggests that tasks which students believe can be accomplished with reasonable effort promote better engagement – this may be enhanced if the outcomes are divided into short-term goals. Similarly, Brophy addresses the need to focus on achieving success rather than avoiding the need to try.

When the application of skills being leant in the classroom is being studied (as opposed to purely academic achievement), the very nature of achievement may be changed and it may therefore be possible to alter student perception of this likely success.

Meaningfulness (Brophy, 1987, Wigfield & Eccles, 1992)

Tasks where students perceive meaningful reasons for engagement in the activity are more likely to encourage them to seek to understand and engage more, thus creating a mastery mindset (Brophy), the converse being that they will decline to engage with a task seen as irrelevant or which they do not value (Wigfield & Eccles).

Tasks can be meaningful because they make sense to the students or may derive from the fact that tasks draw on students' prior knowledge or experience, teach life skills, foster self-understanding, or appear to be relevant to future study or work.

It is questioned whether this is actually the sole outcome of "meaningfulness". It must surely be possible for tasks to have meaningfulness and external usefulness while not causing students to wish to learn more or more deeply. An apprentice who learns to assemble an item may become better at assembling the item (become faster, more accurate) up to an optimal level. There is no reason why the skilled and satisfied workman will feel the desire to assemble different items or use a different approach – some will do, but there will be others content to have mastered sufficient skills for the job and need no more. The same can apply to academic study in schools.

Blumenfeld (1992) suggests that students may engage in more strategic learning if this learning is known to be useful in an out-of-school context, compared to learning which builds on existing

knowledge gained within school. However, what is not questioned is the assumption that strategic learning is necessary for effective learning.

Perceived control (Malone and Lepper, 1987, Ames and Archer, 1988, Blumenfeld, 1992)

Ames and Archer suggest that mastery orientations are promoted in classrooms that afford students autonomy and decision-making. Students are encouraged to be meta-cognitive in establishing goals, developing learning strategies and evaluating the use of these strategies and task solutions. The question is how teachers can allow for choice and autonomy while scaffolding the learning of less able learners. Blumenfeld further questions whether all options or choices are regarded as "real" by students.

Tasks which build understanding

Tasks where students are focussed on developing an understanding of the content are likely to be more motivating (Brophy, 1987).

Blumenfeld (1992) points out that didactic teaching, aimed towards the passing of narrow standardised tests fail to develop deeper understanding, hence making the knowledge gained inapplicable outside the narrow school environment. In contrast, when students have the chance to engage in tasks which are a) complex b) relevant to the world outside school c) in an environment which is comparable to everyday life, the situation and quality of learning will be very different. Students are likely to access multiple sources of information including other individuals, engage a more sophisticated range of cognitive skills leading to a deeper cognition of the problem and potential solutions. This situation is likely to occur when students are set complex problems to solve, similar to those which might be found outside the school environment. Knowledge gained will be flexible and applicable in a range of situations rather than fixed and narrow.

This view may be challenged when a narrow range of learning is all that is required – where simple skills or knowledge is needed, there should be no imperative to create broader range of learning. While this is a rather utilitarian view of education (in its broadest sense) its validity should not be disregarded.

Personal relevance (Brophy, 1987)

Brophy suggests that students will be motivated when they have enthusiasm for a project and that this can be increased where reasons are found to make the topic meaningful and communicating these reasons to the class. While the link to future work-place skills are not specifically mentioned, he does state that being specific about the skills which are to be gained by completion of pieces of work will be motivating to students. Toulmin (1972) points out that learners' knowledge is affected not only by how it is represented but how it is used in their community, and Pintrich, Marx & Boyle (1993) speak of motivation arising from the use of knowledge to solve real-world problems.

Expectancy x value theory (Feather 1982)

The effort expended depends on degree to which they expect success if they apply themselves and the degree to which they value the outcome. Both of these factors are essential pre-conditions of participation. When skills required for the future work-place are taught in lessons, it is reasonable to expect that students will value them, should they be aware of this future efficacy.

Interest (Brophy, 2007, Malone and Lepper, 1987)

While some pieces of learning may be intrinsically interesting to students, there are elements of schooling (compulsory attendance, compulsory subjects, etc) which mitigate against this. Adapting the tasks to meet the students' own interests, creating variety in those tasks or allowing choices and autonomy may all help to generate such interest. Would the use of their learning outside the school context be sufficient to garner interest? Brophy posits that all students can be motivated to be successful in all subjects using a variety of techniques, suggesting that fostering students' motivation to learn may be more realistic than finding ways to make every subject intrinsically motivating.

Students developing their own learning strategies (Pintrich and DeGroot, 1990, Wolters, 2004)

The hypothesis regarding achievement goal theory concerns a link between goal orientation and learning strategies. Commonly, studies have recorded that students adopting a mastery goal orientation also use more adaptive learning strategies.

The use of skills relevant to the work-place and real life as part of the school curriculum

Extensive studies, detailed earlier, examine the importance of motivation in student performance. There is extensive documentation about schools using careers education and vocational training to prepare students for the work-place. However, academic literature does not appear to contain any studies where the specific applicability of skills leant *within the academic curriculum* is used as a means of motivation. This, therefore, appears to be the area where some totally new research would add to the body of knowledge.

This study is whether explicit links to work-place and real life skills in school lessons serve to motivate students. Key to this question is whether existing theories of motivation might be augmented by consideration of these links in the following ways:

Self-efficacy: It is hoped that if students achieve an initial level success in their work, self-efficacy will be improved and this will encourage them to learn more. However, it is suggested that, since this in centred on the students' own self-belief, it is the *perception of their own success* which is important. Bandura (1993) and Dweck (1986) do not suggest examples of how this perception of self-efficacy might be *artificially* improved, and it may be that, where specific skills can be shown to be valuable outside school, the achievement of these skills may enhance students' self-belief.

Self-worth: The focus on the utilitarian value of a set of skills (which can be achieved by linking them to future work-place importance) should encourage students to see the value of such skills. It is hoped that, in addition to enhanced self-efficacy, this will improve self-worth. Would Covington's theory extend to students seeing themselves as efficacious operators in a future work-place or effective in organising their home lives rather than just narrow academic success? This would be of particular importance for those for whom academic success had previously not been easy and might provide the route to motivating this group.

Rewards: Schools are good at creating internal rewards for students who perform well – on a range of measures, academic and non-academic. Were these rewards to be *external* ones (such as validation from outside school), the question would be whether these would be valued more highly

by certain types of students, even if the rewards were less tangible and more distant. Would efficacy in a future work-place be sufficient to create a school-related academic goal?

Sense of belonging: Could Weiner's "sense of belonging" be enhanced if the explicit link to a future work environment is stressed? The link with future work may create a sense of belonging in students who have given some thought to a career; it remains to be seen whether Weiner's theory can work backwards – whether a sense of belonging may lead to a mastery mindset.

Relevance: Where Seifert suggests that students avoid work if they see no reason for it, would the relation of the work to employability (or other real-world) skills provide this reason? It is suggested that Brophy's "meaningful activities" would, indeed include future usefulness. Studies by Blumenfeld (1992) and Toulmin (1972) certainly seems to suggest so.

Building understanding: Blumenfeld's work suggests that understanding is enhanced by engaging in complex multi-faceted tasks, in particular those which are "relevant to the world outside". Were school tasks to be constructed which emulated a work-place environment, it is hoped that this condition would be satisfied.

Group work: Would the co-operative structures, which Ames, Slavin and Sharan believe create motivation in the classroom be enhanced by projecting forward to a work-place environment? Groups of workers often need to work collaboratively in order to achieve a common goal. Emulating the work-place in the classroom might therefore logically lead to more work in groups.

The two goals, performance and mastery, may also be enhanced by students' experience in the classroom whereby they learn about the value of the material they cover in their future life. It is important to establish whether either of these goals, or both, are promoted by this kind of classroom experience.

The utilitarian approach which a link with work-place skills is likely to engender is likely to encourage a performance mindset, although, importantly, Blumenfeld stresses that both mastery and performance mindsets can be encouraged simultaneously without being detrimental to each other.

Performance goals: Where a piece of learning is linked specifically to future work-place and real-life usefulness, it may be that this will this encourage a performance goal mindset, as it links the learning to specific efficacy rather than the value of the learning for its own sake. This leads to the question of whether such work-place links are in fact valuable in school learning. It is clear from Dweck et al that a mastery mindset is likely to lead to higher quality, deeper and more effective learning for school students.

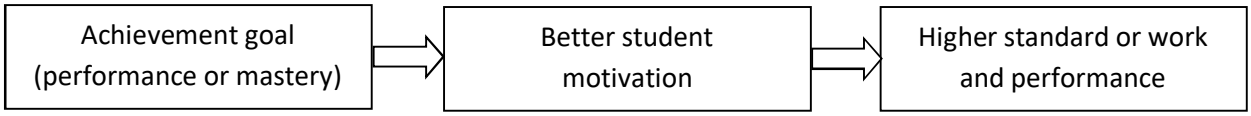
Mastery goals: It may be that Butler's "intrinsic value of learning" includes its future usefulness, in particular in a situation remote in distance and time from the learning. Would the desire to improve (and ultimately master) various skills as described by Brophy (1983) extend to skills which are neither specifically academic nor immediate but more useful (in a practical sense) and long-term? Will Garner's adaptation in the face of temporary failure be enhanced if students think that the skills they are developing will be useful in their future?

It appears that, on the face of it, if the use of work-place and other skills does have an effect on a student's goal mindset, the utilitarian nature of the work will lead to more of a performance

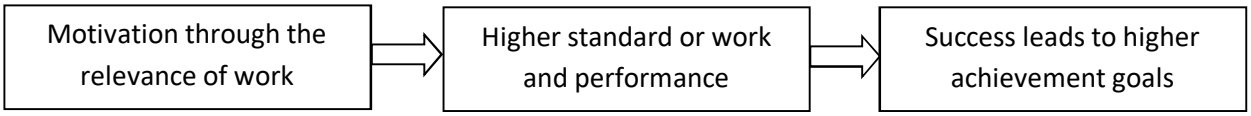
mindset. However, there are many bi-products of the learning which in themselves may encourage a mastery mindset.

A model of goal theory suggests that goals lead to better motivation which in turn leads to a higher standard of work and performance (model 1). This is a traditional model of goal theory as articulated by Ames (for example).

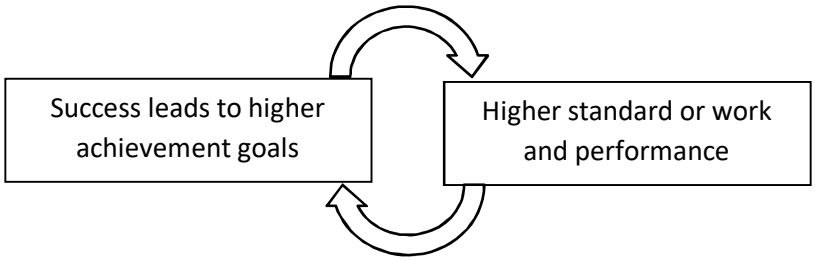
Were external motivation to be provided, such as the value of the skills in later life, it might be that this directly leads to the higher standard of work which, in turn, leads to achievement goals (model 2). This might be an illustration of performance goals, provided that the concept of success is known to the student: in this way the experience of visible success provides the necessary motivation to work harder still. However, this model is equally applicable with mastery (learning) goals, since the higher standard of work leads to greater understanding, pride and satisfaction which in themselves are motivating (Jagacinski & Nicholls, 1984, 1987, Elliott and Dweck 1988) or confidence in their ability (Seifert 2004). The last section of model 2 is really an extension which could equally be added to model 1. In fact, it might be that better student motivation and a higher standard of work and performance are inter-joined in a continuous positive feedback loop (model 3). Motivation through the relevance of work can feed into the loop on either side.



Model 1



Model 2



Model 3

This study aims to test the extent to which motivation can be enhanced through adjustments to curriculum (specifically by introducing work which explicitly develops the mathematical skills needed in the future work-place and real life, hence increasing the perceived relevance of this work) sufficiently to begin this cycle of improved performance and motivation through goals.

Chapter 4: AIMS OF THIS STUDY

This study aims to answer the following questions:

1 Does a specific link to work-place and real-life skills lead to better engagement in mathematics, more time being spent on task and consequently better results?

The work-place and real-life skills need to be fully embedded into the curriculum and teaching and it needs to be clear that the focus of the learning will lead to skills valuable outside the school environment. This focus needs to be in a defined part of the school learning in order to compare it to other areas of learning where work-place skills are not being stressed.

The engagement, the time on task and the academic results are indicators of motivation but there is no single metric which can be a proxy for motivation. Qualitative data will be needed to evaluate the extent to which the focus on real-life skills is the sole reason for this motivation or whether other factors may come into play.

2 Are certain types of student more susceptible to these strategies?

Having established whether students can be better motivated by these changes in the curriculum, it is then important to establish which students have been most affected by these strategies (for example prior attainment, background or those most able to identify the future application of their work). The analysis of the different effects will need to be linked with the result of different students in order to establish these connections.

3 Does learning linked specifically to skills for the work-place and real life tend to lead to a change in mindset, and is it a performance or a mastery mindset? How can this mindset be measured?

While there no direct way to measure mindset, it can be inferred by student behaviour, for example the quality and quantity of effort put into a task or the desire shown to understand a concept more deeply. While most of the studies have suggested that the mastery mindset is more valuable for extending students' learning, does this related only to a narrow field of academic learning? Does a performance mindset act to the detriment of learning?

4 Have academy schools used the curriculum freedoms open to them to introduce motivational aspects to their teaching such as work-place learning?

The final question to be answered is whether academies have taken advantage of the freedoms to vary the curriculum which have been offered to them. The example considered in this study is a curriculum which stresses the future value of material learned has been introduced in schools, but there is no reason why a different variation should not have been tried. Where there has been such variation in the curriculum, the question is whether this has been valuable in raising attainment.

Chapter 5: METHODOLOGY

Existing theory

Existing research into the motivation of school-age students suggest that this may be increased in the following circumstances:

1. Students believe they will achieve success (this is **self-efficacy theory**, Siefert 2002, Bandura 1977 and 1993, Schunk 1984, Dweck 1986). These studies are consistent in the positive ie if they believe they can do it, they will be more highly motivated. However, the negative has not been shown in two respects a) those who believe they cannot achieve success are not *necessarily* de-motivated to such an extent that they do not attempt the task and b) those who are badly motivated may not be so because of their lack of self-efficacy (eg they may be "bright but bored", Siefert 2004, or simply uninterested). Self-efficacy may be demonstrated by adaptive, mastery behaviours, rather than those behaviours which support or protect the ego.
2. The students attribute the ability to complete a task successfully to a factor which is within their control (such as greater effort, strategy or time committed) rather than to a factor which is outside their control such as innate, fixed intelligence. This is Dweck's (1986) **attribution theory** and is fundamental to whether students feel that is will be worth their while trying to achieve success in a task or whether their expected success or failure has been pre-determined. Seifert links self-efficacy theory with attribution theory: where self-efficacy theory predicts whether a task can be done, attribution theory establishes the reason why. Again, this theory does not account for students who cannot see the point in attempting the task.
3. Students root their own perceived worth or value on their ability to carry out a particular function (**self-worth** theory, Covington 1984). Since this now gives the completion of the task quite high stakes, it creates a big dis-incentive to take risks in this regard.
4. Students may establish achievement goals (Locke 1968) which evaluate the incentives to complete a task successfully and hence create aspirational goals. These are what determine task performance (Chacko and McElroy 1983) in what has become known as **goal theory**. Goal theory is further divided into performance goals and mastery goals (Ames and Archer 1987) both of which have implications for the motivation to complete tasks, how a student regards himself and the view that student has of the task and what its successful outcome might be. Adoption of mastery or performance goals will depend on the attribution which students place on their ability to complete tasks and, hence, whether they will find it worthwhile to invest additional effort into the tasks.

It is further important to note:

With a mastery goal mindset, students may focus on the intrinsic value of learning (Butler 1987), be self-regulating and self-determining (Siefert 1997), spend more time on tasks (Butler), spend more effort overcoming difficulties (Elliott and Dweck), prefer challenging tasks and taking risks (Ames & Archer, Elliott & Dweck), an intrinsic interest in learning activities (Butler) and positive attitudes towards learning (Ames).

With a performance goal mindset, students may be more likely to regard their anticipated success as being outside the zone of their own control and dependent on fixed attributes such as intrinsic ability (Dweck, Covington, Nichols, etc), being determined by their performance relative to others (Dweck, etc). Their success is seen to be linked to self-worth (Covington and Beery 1976), they may believe that learning is only a means to achieve a goal (Nichols 1984) and they may be less likely to choose challenging tasks (Dweck and others) and have a desire to achieve with the minimum effort and to adopt superficial or short-term learning strategies.

What happens in schools

The researcher is a teacher and school manager with many years of experience. The aim in this study is to create data which can be used to enhance the school curriculum and teaching methodologies.

The study is approached from the view-point that:

- The curriculum is largely pre-determined (although schools do have varying amounts of freedom in this regard such as the choice of examination board and the ability of academies to deviate from the national curriculum).
- The method of delivery of the material is very much a matter of choice for the school and the teacher.
- The motivation of students is at least as important as the skills of the teacher or the curriculum, although of course the latter two will impact on motivation.
- In British schools, teachers and school authorities generally believe that motivation is based on:
    - ❖ the assumption that students wish to attain high examination results – which is true in many cases, but it is those who lack such motivation who are of most interest here
    - ❖ a system of artificial (and fairly Pavlovian) rewards and punishments which become less effective as students approach the school leaving age
- It is the students' perception of the actual value of learning which is often lacking and hence worthy of further study.

Over-arching aims of this study

The aim of this study is to consider whether changes to the curriculum (in this case the mathematics curriculum) have an impact on the performance of students by motivating them more effectively.

The study looks at various behaviours of the students in order to establish whether their experience at school is motivating them to achieve. In the course of the study it is possible to measure various inputs and outputs and to observe whether there is a correlation between these variables. Will, for example, a change in teaching technique lead to an improvement (or deterioration) in examination performance?

These correlates are easy enough to establish. The performance of target and control groups can be compared at different times and differences may be observed and they may be compared to the changes in the teaching, curriculum and exercises. However, schools and classrooms are complex places and it is very difficult to avoid a whole raft of confounding variables, any of which may come into play. It is also important to remember that, while correlation may be observed, evaluated and even predicted, this falls some way short of a causal effect.

In order to establish whether a student's change in motivation has been responsible for a change in outcome (eg academic performance) the traditional theories may be useful in identifying in what way motivation has changed, the reasons behind it and what further effects this is likely to cause.

Does a particular activity, for example, lead to more self-efficacy? If the ability to complete a particular task is linked to skills required in the work-place, will this improve self-efficacy in comparison to a purely theoretical task? Is there a way in which the choice of tasks can lead students to attribute their success to effort rather than ability, hence developing more of a mastery mindset? Will completion of "real-world tasks" lead to better self-worth? The answers to these questions are not going to be easy to garner: simple figures indicating better or worse academic performance will not identify under-lying attitudes and beliefs; the use of the questionnaires and interviews are more likely to be able to do this.

It is also important to consider whether certain tasks are more likely to engender a performance or a mastery mindset. Perhaps, where the skills are seen to have real use outside the school environment, this could be only as a means to achieve a goal (Nichols) thus engendering a performance mindset. Alternatively, the success achieved might encourage students to wish to study more deeply and for longer, and hence the mastery mindset. Finally, as Blumenfeld points out, it is possible that both types of goal can be encouraged simultaneously. The use of some open-ended tasks will give an indication of the motivations behind some of the students: those who engage more fully in order to create more sophisticated solutions over a longer period of time might be showing more of a mastery mindset, whereas those who do the minimum in an attempt to complete the work in the minimum time with the minimum effort might be showing more of a performance mindset.

In this study it is important to consider Brophy's enquiry when considering our results – if a task is seen to be motivating for students, could it be that the task is purely motivating them to achieve in that task or could it be that the task motivates them to learn. This is difficult to ascertain; it might be apparent from responses in the interview or from teachers' comments about the engagement of students in the tasks.

Of Brophy's 33 strategies for motivating students to learn, three are of particular interest:

- Calling attention to the instrumental value of academic activities
- Inducing task interest or appreciation
- Task-related thinking and problem solving.

Brophy (1983) and Wigfield and Eccles (1992) suggest that meaningfulness will be a motivating factor and they include "life skills" as part of that meaningfulness.

Blumenfeld specifically mentions that tasks will be motivating if they are known to be useful in an out-of-school context especially if these are complex, problem-solving exercises.

Brophy speaks of the necessity for "personal relevance" for a piece of learning to be motivating, and Toumlin (1972) and Pintrich et al (1993) speak about the use of skills and knowledge in the community and in real-world problems.

This study attempts to relate positive educational outcomes, which are caused by specific reference to the application of mathematics within the curriculum, to as many as possible of the above factors within a piece of school work.

This experiment uses an adapted and an un-adapted curriculum with the target and control groups. The adapted curriculum contains specific reference to the value of the subject and the material studied in later life and work, specifically demonstrates how the material covered is relevant to real-life work and couches the exercises and tasks in terms of real-life situations. It also uses open-ended tasks which are posed as problem-solving exercises. In these ways, it is hoped that the adapted curriculum satisfies Brophy's requirements for a motivating learning structure and Blumenfeld's requirements for meaningfulness. We will also seek evidence for the development of performance and mastery goals in the course of the study.

Methodology

This study sets out to determine if some factors of curriculum delivery are able to create motivation for students to engage more in their studies. In line with the positivist tradition, it created target and control groups, varied the inputs and measured the outputs.

The inputs were varied by changes to the curriculum and teaching methods, as detailed below.

This motivation was measured by a range of outcomes, for example

1. Asking them about their motivation (including whether they enjoyed the learning)
2. Asking teachers about the classes' motivation
3. Observing and measuring their engagement in the task
4. Evaluating their understanding of the learning (eg through assessing their work and tests)

Some of the outcomes were quantitative: the assessment of understanding can be distilled into a series of numbers representing the extent to which the students have acquired, and are able to apply, a range of skills which have been taught in the lessons. This allows easy comparison between target and control groups. Engagement in lessons can also be measured quantitatively, for example the proportion of time spent on the task, the quantity of work produced in an open-ended task – both of which could be an indicator of the level of motivation felt by the students. In this respect, in order to answer the fundamental question of whether teaching methods can affect motivation, quantitative data can suggest a more certain answer.

Others outcomes are qualitative. Method 1 (above) will be determined by gauging their opinions through questioning both in writing (questionnaire) or face-to-face (interview). Engagement in the task might also be described rather than measured numerically, and the quality of the work in open-ended tasks might have a qualitative aspect. However, the main qualitative element of the data gathered was around the question of WHY. Why have you scored more in test A than test B? Why did you find this more interesting? Why did you produce much higher quality work in task A than task B? In this way the qualitative aspect will serve more as an explanation to the quantitative data. In addition to creating an explanation for the quantitative results, the qualitative results may also serve to create (or to disprove) validity. For example, the answers to the questions WHY might lead to reasons wholly external to the teaching methodology.

Methods

The construction of the study involves specifically adjusting the curriculum in a school in order to demonstrate the value of the material studied for future careers. This takes two forms:

- Explicitly highlighting the real-life application of certain mathematical skills which are learnt in the classroom in the course of a normal lesson in an academic lesson.
- Identifying certain professions or jobs which require specific academic qualifications in order to enter them.

The un-adapted curriculum involves questions of an entirely theoretical nature, where questions bear no relation to the circumstances in the real world in which such calculations might arise. Some videos are shown but these are not in any way related to the applicability of the mathematical methods in the real world – they are used solely to provide an element of balance (one class has a video and therefore the other one does too in order to avoid the method of delivery being the motivating factor). The exception to the theoretical nature of the material is the open-ended task which is based on a real-life situation. All the explanation of the mathematical methods is purely theoretical with no mention of the applicability of the techniques.

The adapted curriculum contains a small number of simple, theoretical questions to illustrate the calculation methods. The remaining questions are all of a nature which stresses the applicability of the techniques. The following elements are introduced into the adapted curriculum in order to stress the ways in which the mathematical methods can be used in the real world:

Topic 1

- A video in which individuals from a range of professions explain how they use various mathematical skills and techniques (relevant to the topic being taught) are used in their work.
- A brain-storm in which members of the class are invited to suggest ways in which the topic being studied will be useful in different jobs and in general life.
- Finding a percentage of an amount and one quantity as a percentage of another in real-world contexts.
- Application of percentages eg tax, tips, commission, sales increase, proportions in food, repeated increase.
- Discussion led by the teacher of how the use of maths (and in particular percentages which is being studied) is valuable in the world of business.
- Examples given by the teacher of how fractions are used in the real world. Examples use the four functions with fractions.
- Dividing in ration using real-world examples.

Topic 2

- Introduction and example of the use of area in real-life contexts.
- Video about finding area of shapes and its use in the real world.
- Brain-storm about which professions might use area calculations.
- Areas of circles, sectors and rings in the real world – exercises.
- Use of Pythagoras' theorem in real-life situations.

The methods intended for this case study are experimental ones. Two classes are selected and they study adapted and un-adapted curricula; various outcomes from the class are measured.

The process is:

Split the group of students into two classes, subjecting one to an adapted curriculum where the teaching makes specific links to learning which will be of value in the work-place and real-life situations. A second unit of work also uses a similarly adapted curriculum but with the other class in order to try and reduce bias.

The performance within each group was measured by:

- Observing lessons and creating a judgement of the
    - ❖ Engagement of the students (time and quality)
    - ❖ Work quality of the students
    - ❖ Work quantity of the class
- Assessing the work produced by the students, especially open-ended tasks and work carried out independently
- Evaluating the longer term academic achievement of these groups
- Interviewing students with questions which seek to ascertain
    - ❖ How interesting they found the work
    - ❖ How useful they felt the work was
    - ❖ How well taught the work was
    - ❖ How well prepared they thought the lessons were
- Interviewing teachers with questions which seek to ascertain
    - ❖ How they viewed the students' engagement
    - ❖ The students' attitude to the work
    - ❖ The quality and quantity of the work produced

While there were some open-ended questions in the interviews, where possible, data was converted to numerical scores to enable comparisons between the target and control groups during the different units of work.

Chapter 6: RESEARCH DESIGN

Introduction

The aim was to test whether school pupils were motivated to perform better in academic subjects (mathematics in particular) if they believe that the material will be of value in the real life. In order to test this, the curriculum was adjusted to include references to future applicability in the work-place and real life as well as providing exercises and tasks which made this work-place link very clear. This adapted curriculum was applied at specific times and with specific classes and compared to control groups. A range of tests on the target group and the control group were performed to see if this adjustment of the curriculum had an impact on the motivation of the students, hence improving performance.

Selection of school and timing

It was important that the research should take place in a school with mixed levels of attainment and motivation among pupils. The researcher needed access to a large group of pupils, as well as their attainment data and the teachers and parents as needed. The school selected is a North London comprehensive with a broad span of students in terms of intake and academic outcomes. The researcher is a senior member of staff in the school.

In the school selected, the student population, especially in year 10, is regarded as a slightly unco-operative one. Whilst not lacking in intelligence, they are sometimes reluctant to work and can be disruptive. This may take the form of a) failure to work effectively in lessons b) disrupting lessons eg by refusing the listen to the teacher, by disturbing other students when trying to work c) refusal to work at home. The school has in place a variety of strategies to eliminate this behaviour, such as a) instant removal from lessons, b) follow-up on disruptive behaviour after school, c) one-on-one target-setting meetings. There is also follow-up when homework is not done correctly or on time. However, there is not a whole-school initiative to discover what type of work (in terms of both content and delivery) will be most motivating to the students.

The research was planned to take place during the second half of the summer term, in the period after the public exam classes had left the school in order to allow for more teacher time.

Selection of subjects

Subjects need to be selected on the following criteria:

The nature of the syllabus needed to be essentially academic but with scope for drawing links between materials learnt and real-life work. If the subject is already largely vocational (eg business studies) there may not be the scope for adjusting the curriculum. Others may be incapable of being adjusted to provide the real-life skills, eg RE, art, or to have skills which fall too much into a “niche”, eg history, geography, languages.

There also needed to be a reasonable number of students studying the chosen subjects, organised into several teaching groups which could be divided into targets and controls; ideally these groups would be comparable in terms of prior attainment, motivation and quality of teacher. There also needed to be agreement from the teachers within the chosen faculties.

The following subject areas were considered:

Mathematics

All students study for GCSE at either higher or foundation level. Within each tier the students cover a common syllabus. They are arranged in ability sets, although there is little variation among the middle sets.

English

All students study for IGCSE English language and GCSE English literature. They are arranged in ability sets.

ICT

All students study ICT up to year 11. Some study for a BTEC and others for GCSE. Aside from the GCSE/BTEC split, there is no ability setting.

In the first instance, it was decided to carry out the research using mathematics, with the possibility of conducting further study, if needed, in the English and ICT subject areas. There are many reasons for this:

1 From a personal point of view, the researcher would be able to direct the work effectively (as a mathematics teacher);
2 Academic results (tasks and assessments) are easily quantifiable as they are very objective thus removing possible elements of bias;
3 Everyone in a year-group studies maths. This makes for a broad population from which to draw samples; it also means there is a considerable variation of the motivation of those studying it.

All students study for GCSE mathematics at either higher or foundation level. Within each tier the students cover a common syllabus.

Selection of students

The students most likely to be affected by an adjusted curriculum will be those who a) do not yet have the motivation stemming from impending public exams and b) are old enough to have begun to think about future careers and the skills and qualifications needed to enter and succeed in those careers. It would also be unlikely that the school would agree to any experimentation with exam classes.

In many secondary schools the first careers conversations take place in year 8 and no public exams take place until year 11. The sixth form is very small comprising only year 13. Therefore years 8, 9 and 10 are possible target year-groups.

Since the issue of motivation appeared to be highly relevant in year 10, it was decided to conduct this study using those students.

In year 10 the school has 6 maths sets, ranged by ability. This study uses sets 3 and 4 out of 6; with this set-up (maths ability being presumed to follow an approximately a Gaussian bell-curve with large numbers occupying the central range of ability and fewer towards each extreme), there should

theoretically not be a large variation in the ability within and between these sets. An analysis of their initial ability is presented in the *results* section and consists of YELLIS tests and predictors as well as past performance in mathematics.

The creation of target and control groups

The two groups selected for the study contained around 20 students in each.

Two sets of topics were to be chosen, lasting approximately 3-4 weeks each. For each of these topics the curriculum could be taught in two ways:

1 In a straightforward academic way, as it appears in text books with no attempt to relate the work to future work-place skills (the "un-adapted" way).
2 The "adapted way" – including a range of examples of where the material will be useful in various jobs or the world outside school and where the majority of the teaching will involve questions set in a work-place environment.

At any given time, the group studying the un-adapted curriculum would be the control group while the one studying the adapted curriculum is the target group.

See the detail in *Work with the groups and time frame* below.

Selection of topics

When constructing a maths curriculum, best practice has generally been to use as many examples as possible from the real world as opposed to purely theoretical tasks.

The vast majority of maths topics have use in the real world at some level although in some cases this is at a very high level. (An example might be complex geometric reasoning: the construction of mechanisms and hence a range of both machines and structures is based on the rules of geometry. However, this link will not be at all obvious to secondary school pupils. Another example might be the use of algebra in computer coding.)

There are other mathematical topics which are almost exclusively practical – an area of the syllabus called "functional maths".

For this study, topics which fall between these two categories need to be found.

Topics such as area and percentages have clear practical applications at secondary school level, while it is also possible to teach them in a more theoretical way. The material can therefore be stretched in both directions:

A On the theoretical side problems can be presented as purely academic tasks.

B On the practical side, the use of the methods needs to be projected into a work-place environment in order to make it relevant to this study.

Topic 1 was therefore chosen as **Number** and included percentages (with links to fractions, decimals, increases and decreases using percentages, multiple increases such as compound interest rates) as well as ratio.

Topic 2 was chosen as **Area** (basic areas of 2 dimensional shapes, leading on to compound areas in two dimensions, nets of solids, volumes of 3 dimensional shapes, leading on to practical problems such as covering areas of walls with paint, etc) as well as Pythagoras' theorem.

Work with the groups and time frame

Time Block 1

Set 4 studied **percentage** with an **un-adapted curriculum**. Very limited references were made to applicability of the material to the work-place and it is very a theoretical, academic topic. However, some of the material was specially prepared so that it appeared to be as "special" as the adapted curriculum topics. Care was taken that the adapted and un-adapted lessons both prepared students fully for the assessments, and at all times the work followed the common, published curriculum as studied in the rest of the classes within this school.

Set 3 studied **percentage** with the **adapted curriculum**. The explanations and questions were almost all real-life examples and the teacher stressed the value of this material in future jobs. The lessons included introductory talks, activities and videos which made specific reference to the value of maths in the work-place and the maths tasks were also very much focused on the real-world application of maths.

Set 4 (un-adapted) did include some introductory videos but these were about the topic in general rather than the applicability of maths in the work-place. The use of these videos was intended to ensure that one group was not motivated purely by the use of video as a medium of teaching.

The teachers were aware of the research and its objectives but the students were not (as their knowledge of the specific attributes being measured could lead to bias).

Each of classes were observed (as in an inspection) several times with comments recorded on all aspects of the teaching and learning. These were conducted by the same person – the researcher. Each class was set one homework which took the form of an open-ended task allowing students to spend extra time or effort on it if they wished and this task was common to both groups. Some of the classroom tasks were also common to both groups to allow direct comparison.

The assessments and homeworks were all marked by the researcher (ie the same person) to avoid any possible bias or error. It also meant that the work was assessed by an individual who did not know the students at all well, nor have any kind of personal interest in either of the classes performing better.

At the end of the time block, each group had a short assessment, along with a short questionnaire asking about: how interesting the work was, how useful the work was, if it was well taught, if they feel they could now use the material.

At the end of the time block, the teachers completed a short questionnaire asking about how they found the students' engagement, attitude to work, quality and quantity or work covered. They were specifically asked to compare their class's performance across the two topics.

Time block 2

Set 4 studied **shape** with the **adapted curriculum** as above.

Set 3 studied **shape** with the **un-adapted curriculum**.

The observations, questionnaires and analyses were conducted during or at the end of the block as in block 1.

Using this method of switching the two groups, it was hoped that any bias in the groups or teacher could be removed or reduced – ie set 3 might have a generally more positive view of the school and maths or have a more motivating teacher. Having 4 sets of data should allow this bias to be reduced.

	Set 3	**Set 4**
Time block 1	*Number* with the **adapted curriculum**	*Number* with the **un-adapted curriculum**
Time block 2	*Shape* with the **un-adapted curriculum**	*Shape* with the **adapted curriculum**

Justification

The time-frame of 3-4 weeks for each time block is long enough for the students to involve themselves fully in the task and to familiarise themselves with the way of working. Ideally the break between the two blocks of work should be the summer half term so that there is a natural break between topics and methodologies. This would allow students to consider "before half term" and "after half term" while being reminded of the different topics. If there is more time that this, it would be a struggle to create self-contained modules of learning. In addition, it is necessary to complete the study within the one term, allowing for a little setting up time at the start of term and the opportunity to follow up after the study.

Unfortunately a number of last-minute changes to the plan for the term meant that the second period of time was shorter than the first, where they should have been the same. However, both groups had the same number of lessons as each other on each topic.

Follow-up

Once this task has been completed, a further pair of topics or classes could be examined if necessary. This might take place within the same groups and same subjects, or different ones. It might be possible to examine (largely) the same students in a different subject – either split in a similar way (there may be commonality in the maths and English setting, for example) or differently (unlikely to be much commonality between the core subjects and ICT, which is an optional subject).

Parents could be surveyed asking whether their son/daughter has enjoyed the topics being taught, whether they have achieved within the topics, whether they have willingly engaged in home learning in these topics, whether they have spoken with enthusiasm about them and whether they feel the topics have been useful.

If the methodology is flawed in some way and does not give useful information, it could be adapted and tried on a totally different group of student, such as a different year-group.

Curriculum adaptation

To attempt to manage extraneous influences, the teaching should be, as far as possible, a) the same as it usually is and b) consistent between the two groups. Naturally these two requirements are incompatible with each other unless the two teachers teach in exactly the same way (which they do not). A number of resources were therefore produced which attempted to standardise teaching methods and content.

- Display resources outlining methods, formulae, etc (RESOURCE 2, 4, 5, 8, 14, 18) – these were common to both groups.
- Only one of the exercise sheets was common to both groups (RESOURCE 3).
- The other exercise sheets varied to allow for the adapted and non-adapted versions of the curriculum. All sheets were written by the researcher, so the novelty of using sheets instead of a text book, or something written in a different style, should not be relevant to one group rather than another.
- Brainstorming exercises (and recording sheets) were only used for the group doing the adapted curriculum – one exercise used for each group. This task was carried out in small groups, which the students enjoy. It might therefore be the group-work or open-endedness of the task, rather than the actual content, which was motivating.
- Videos highlighting the use of maths in various jobs were used for the group studying the adapted curriculum. This might similarly provide motivation outside the scope of relevance to the work-place, as students like watching videos! One video was shown to both sets simultaneously.
- The material for the open-ended tasks was identical for both groups. In both cases, the researcher was involved in introducing the work to both groups and helping them. On one day, both regular teachers were out on a trip and both classes were covered by supply teachers with the researcher moving between the two rooms. In some ways this was the ideal way to compare the groups as neither had their regular teacher and both had the same "expert" to assist.

Open-ended tasks

One task was set during each of the two topics.

The first task consisted of three separate activities (calculation of alcohol content of drinks, calculation of food prices for a menu, calculation of nutrition content of food), of which students were asked to select two.

Each of these involved a real-life situation. The task in each case included researching using the internet (or elsewhere) for key facts and figures, then creating a table of calculations and finally offering advice based on the research and calculations. These were real-life tasks based on situations which could be encountered in a work situation. While only one of the groups had studied the adapted curriculum, it was important that both groups did the same task.

The second task followed a classroom activity where students were calculating areas. The task was to design an apartment or bungalow, calculate the areas of all the spaces, choose flooring, investigate its cost, and hence calculate the total cost of the floors.

See Appendix I for full details of the tasks.

Participation

Out of the two classes, only two students (both set 3) refused to sign their consent to participate. While they did complete the class tasks, their results were not included in the summaries.

Attendance was mixed. A small number of students had such poor attendance that their participation in the study was severely compromised. The study of attendance of the two classes is included in the *results* section.

The hand-in rate for the open-ended task (especially the second one) was really quite low – less than 50% for the second one – although this is, of course, a variable which needs to be measured and the causes evaluated.

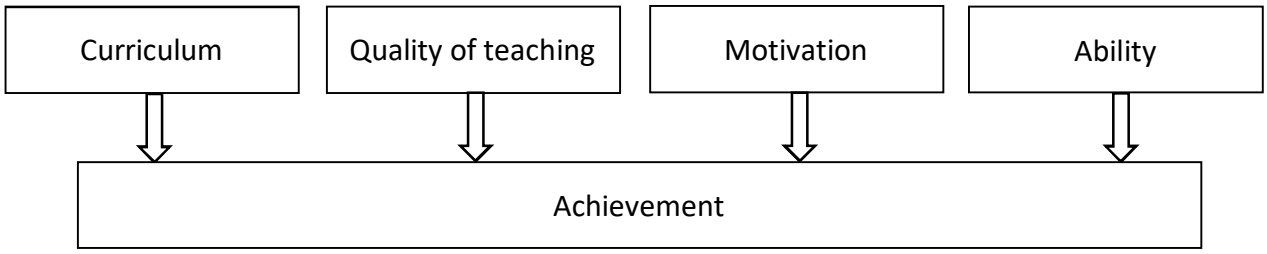
For each exercise analysed in the study, the number of questions attempted is considered along with the number of correct answers. The number of attempted questions may depend on a range of factors, some of which may be controlled by motivation.

Chapter 7: POSITIONALITY, ETHICAL CONSIDERATIONS AND LIMITATIONS OF THE RESEARCH

POSITIONALITY

The researcher is a teacher and school manager with many years of experience.

As a starting position, it is suggested that a range of factors impact on academic outcomes.



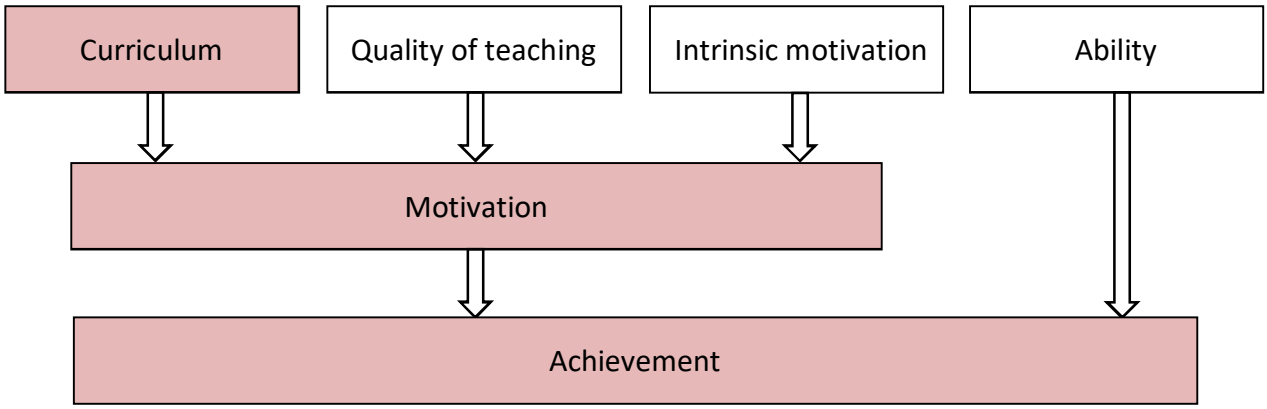
Curriculum: relevance to students, appropriate challenge, appropriate and accessible materials

Teaching: the skills of the teacher, relationships

Ability: the innate ability of the students, which may or may not be fixed (Dweck, 1986)

Motivation: it is suggested that this is a significant variable both between and within schools

The study is attempting to find ways to enhance motivation in students by demonstrating relevance of the learning to future life and work. The methods used in the experiment involve adjusting both the curriculum and the teaching methods, which both potentially impact on motivation. A more sophisticated model is therefore suggested, separating intrinsic motivation (coming from home or the students' desire to achieve) with overall motivation which may be impacted by curriculum and teaching:



Of course the model suggested is a simplification. As an example, ability (often having led to prior success) can easily lead to enhanced motivation.

This study adjusts the curriculum in order to make it more relevant and it is expected that this will raise motivation and, hence, achievement (shaded red, above).

ETHICAL ISSUES AND CONTROLS

This piece of research is conducted on a group of minors in a school situation. While the research posed no physical, emotional or academic risk to any of the participants, the study did make use of the students' data (both generated within the study and other data held by their school). It also created a potentially inequitable curriculum and teaching offer both between the two groups and between those two groups and the rest of the school. The issue of consent by both the participants and their parents was also considered.

The ethical issues were addressed in the following ways.

Consent when working with minors

Each student selected for the study attended a short session where the purposes and the methods of the study were explained, although not the specifics of the adaptations as this knowledge could in itself lead to behaviour change. They also received an explanation on a printed sheet. The same explanation was sent to parents. Students and parents were told to discuss the study and reach an informed consent. Students were asked to sign their consent on a form, parents were invited to object. (The rationale for this was that parents in the school were notoriously bad at replying and therefore to achieve a high proportion of returns would have meant a lot of contact. Not only would this have been time-consuming, but would have drawn too much attention to the project, thus possibly changing its outcome. Also, see the next paragraph.)

The work which the students were undertaking was entirely within the scope of normal work in school. The syllabus was unchanged and the methodologies were entirely within the range of what is acceptable in a secondary school. Questioning students about their work, either in an interview or a questionnaire, is also entirely within the normal work of a school. Interviews were conducted in line with school policy and best practice regarding the safeguarding of children. It was decided not to record the interviews (audio or video) which might have required a higher level of consent.

The part which requires the consent is the use of the data in a study by an external body. The data includes both assessment and attitudinal data from this study as well as data already held by the school ("contextual data"). It is the use of this data for research purposes which requires specific approval.

Two students (and none of the parents) refused consent to participate in the study.

Students and parents were given the option to withdraw from the study at any time, although none did.

Anonymity and confidentiality

Each piece of work, assessment, open-ended task, questionnaire and interview sheet was labelled with the student's name for identification purposes. However, this was then coded into a number when it was recorded as part of the study, alongside the data from that piece of work. The table of student names and codes was stored securely and separately and in this way all the aspects of work concerning a particular student could be linked together but the identity of that student was separate. (It would, of course, be possible to re-connect the codes with the names if necessary, eg if a document was lost or if a student wished to withdraw from the study, but this was not done routinely.)

The original sheets were kept on the school premises but not referred to again in the study. In this way the data was anonymous. All individual data was kept confidential with only the summaries and analyses published in the research papers.

Equal access and fairness

The switching of target and control groups should have ensured that neither of the groups was unfairly advantaged against the other. Since the un-adapted curriculum was very similar to the normal curriculum which would have been in place anyway, it is anticipated that no group would in any way be *disadvantaged* by participation in the study.

It might be that participants benefited from studying the adapted curriculum for part of the study which could then give them an advantage over others. However for the following reasons, it was suggested that this was not unethical:

a) This would count as an innovation in teaching. Teachers are allowed (even encouraged) to innovate with their individual classes. The fact that an entire year-group does not participate does not detract from the value of such activities.

b) The proportion of the curriculum time which is occupied by the enhanced learning will be around 10% of the learning time for the year and therefore any advantage gained will be minimal in the long term.

c) The assessment data from the study will be kept entirely separate from the main school assessment system. Therefore, while these groups may have experienced better learning, their actual performance during the research will not advantage them over others.

d) Should the study be successful, it should impact on the work of the entire department, hence providing an advantage to all students.

e) Should the effects of participating in the study be more wide-spread (perhaps changing these students' attitudes for the better in the long term), this will give them more of an advantage. However, in such an eventuality, it is even more likely that the methods trialled will be adopted universally, again benefiting all.

Debrief

The option was given to students and teachers to be de-briefed about the research findings.

LIMITATIONS OF THE RESEARCH

Time frame

There was a limited opportunity to conduct this research. There was therefore not the opportunity to conduct pilot studies (for example the use of the questionnaires and interview questions). A longer-term study would have involved data from outside the time period, for example exam results from earlier in the year and later the following year in order to obtain a longer-term picture.

Qualitative data

The use of qualitative data in this experiment was to attempt to corroborate the quantitative data collected. There was not the attempt to explore whole new areas of motivational psychology. In this way it was hard to ascertain, for example, the underlying attitudes towards the work which would have been valuable in determining performance and mastery goals.

The questions on the questionnaire and the interview sheet are the kind of questions which the researcher has used in the past when students have been evaluating a lesson as part of the "student voice". For a future study far more detailed questions would be needed, with pilot studies to refine the questions.

However, in this case the researcher is purely trying to compare one set of lessons with another, once class against another and in the search for *prima facie* evidence that the change in curriculum has altered performance through motivation, these simple questions should suffice.

External evaluation of students' work on class

This experiment is based on two classes largely taught by their own teachers. There are clearly risks of bias, subjectivity and inaccuracy. To create wider validity (even within limited topics, a single subject and two classes), other independent staff members could have been used. Were there to have been 20 lessons, staff wholly external to the process of the experiment could have observed the lessons and created more objective data on engagement and quality of work. The views and comments of the teachers were, therefore, only one element of the data collected.

Extrapolation

This study considers a small part of the syllabus in one subject over a limited time-frame. Any findings would, therefore, need to be read in this limited context and not extrapolated to different subjects (or even topics), year-groups or students in a different context.

Chapter 8: DATA COLLECTION

Background / contextual information

In schools a variety of contextual data is used in order to benchmark performance. This data is held by the school and was extracted from the school's databases and not collected as primary data.

YELLIS scores: YELLIS (provided by the University of Durham) uses a cognitive ability test to predict on a statistical basis the likely grades for GCSE. The YELLIS score has a mean of 100 nationally and a number of different aspects. This study will consider 2 of them – verbal score and non-verbal score.

GCSE predictor for maths GCSE: YELLIS also gives a predictor for GCSE grades. The predictor for maths is included in the contextual data.

Internal maths assessment grade: Teachers in the school give a GCSE grade for all subjects several times in the year. This study has used the latest assessment prior to the research (ie March 2015) for maths GCSE. The grade is converted to a number on a scale A*= 8, A = 7, etc.

Additional background information: Proportion of boys, indication of deprivation (as shown by the pupil premium indicator) and English as an additional language. It is not expected to bench-mark the classes using these figures but they are given as part of the context.

The above data sets could be used to bench-mark the work completed in the course of the study against an objective predictor. However, doing this would give rise to many issues such as converting each piece of student data to a GCSE score (or a part-GCSE score). This would be a time-consuming exercise and not particularly useful, since the object of the exercise is compare the two classes with each other and see how this relationship is altered by the different styles of work and curriculum.

Therefore, the intention of providing this contextual data is to illuminate the potential differences in the classes due to factors entirely external to this research project. Each of the data-sets listed above were created prior to this piece of research being started (or even proposed) and can therefore be said to be entirely independent of it.

It should be noted that the YELLIS data is based on a notion of cognitive ability (as tested by cognitive ability tests) and is not based on student performance in class. Having said that, clearly the ability to perform in the tests will be influenced by prior learning.

The internal maths grade, however, is very much a reflection of how much work has been done and the quality of learning in maths lessons. This data-set is useful as background information to compare the performance of the two classes prior to this research.

Student assessment data from the research period

Classwork tasks: A variety of tasks to be completed in lesson time to utilise the skills taught. In each case the number of questions attempted and the number correct (converted to a percentage of the total) was recorded. In cases where the two classes completed different work (being either specifically for the adapted or the un-adapted portion of the work) a comparison between the

classes was not possible. However, it was possible for the teacher to comment on the quality and quantity of the work as well as linking this to general comments about the class's engagement.

Homework (open-ended) tasks: These tasks were designed to be the kind which allowed students to put in a varying amount of effort and time. The assessment criteria for the tasks were known to the students in advance and they were marked as objectively as possible. These tasks were common to both groups and, therefore, a direct comparison could be made between the two.

Assessment: Each student took an end-of-topic assessment relevant to that scheme of work. It was taken under test conditions and marked according to a strict set of criteria. The tasks were common to both sets.

When marking the classwork, homework and tests:

A Papers were anonymised, randomised and marked together so that it would impossible for the marker to create any kind of bias. All the papers from both classes were marked by the same teacher. Only after grades were awarded were the scores re-assigned to their separate classes.

B Data was converted to a numerical score.

C The number of questions attempted as well as the number correct was recorded.

Student assessment data after the period of the study

Students took an exam in the middle of the research period (see appendix I for the time-plan). This was after one class had completed its period of the adapted assessment. It is therefore instructive to compare the performance of the classes relative to each other at this point.

The next examination taken by all of these students was a year 11 exam taken in September 2015. By this point, both classes had completed both pieces of work, including a period with the adapted curriculum for each of them. The research compares what further progress each class made.

Change in rank

One final piece of numerical data was created – the change in rank over the period of the study. The purpose of this part of the study is to compare the effects of the work across the different students in order to see which of them was most affected.

The data considered three stages:

1. Before any of the work. The measure used is the **most recent maths grade**, as created by the teacher at the previous assessment in March.
2. Between the two periods of the study. The measurement used is the **end-of-year mock exam**.
3. After all work was complete. The measure used is the **exam in September**.

For each measure, each student is ranked within their class. The changes in rank are then calculated: change over the first period, change over the second period, changer overall. What is of interest is whether a particular student's rank changes by 8 points or more in a positive or negative direction. In these cases, a more detailed look at those students' answers to the questionnaires and

in the interview are considered in order to establish whether these changes may be due to the adjustments to the curriculum.

Lesson observation

The school operates a rolling programme of lesson observations with staff being observed several times in a term. The researcher is one of the staff members who regularly observes other staff members, so his presence in the classroom was not an unusual event, especially in maths. The school's normal observation pro-forma could have been used, and in addition specific data would be recorded: average time on task for students, amount of work completed, accuracy of work completed, comment on classroom atmosphere.

In the event, this plan needed to be adapted:

Comments and grades on lesson planning: this is not needed as all the lessons were planned by the researcher.

Comments on the validity and quality of materials: as above, this was all provided by the researcher and so grading these would be of no value.

Measuring time on task: After some attempts, it proved to be impossible to obtain a useful measure of time on task. Almost all of the students were on task for the whole lesson and any attempt to judge the quality of their engagement would be too subjective to be valuable. It therefore seemed to be more useful to consider the amount of work covered by the class (measure by the number of questions completed). The problem with that method was that, when tasks were under-taken by one class but not the other, it was very difficult to make a comparison. The most useful measures were, therefore, in this instance the subjective ones from the teacher – as given in both the questionnaire and the interview. The comments were therefore used to enhance and explain the numerical scores given by teachers.

Questionnaires and interviews

After many of the lessons, the researcher spoke informally to both of the teachers to gain feedback on how the lessons were progressing and if any specific good or bad points had been noted. This was recorded in a blog. Occasionally it was possible to make amendments to the curriculum as a result of these conversations. At the end of each block of time, teachers were asked to complete a questionnaire. Students completed a questionnaire at the end of each block of time and this was followed up with an interview with the researcher.

Teacher interview: teachers were asked to quantify and comment on students' engagement, attitude to work, quality and quantity of work covered.

Student questionnaire: students were asked interesting the topic was, how well taught, how easily they could do it, how useful it would be for the future, how well they had developed specific skills (and good they were at the topic) and how much they enjoyed learning maths.

In each of the questionnaires students / teachers were asked to score each of the aspects on a scale of 1 (worst) to 4 (best). It was important not to allow a neutral (middle) option which might allow a lazy respondent not to make a decision. The 1 – 4 scale allows for a broad like / dislike and also a stronger statement each way.

Student interview: The interview followed up on the questionnaire and attempted to tease out some of the reasons for the answers in the questionnaire.

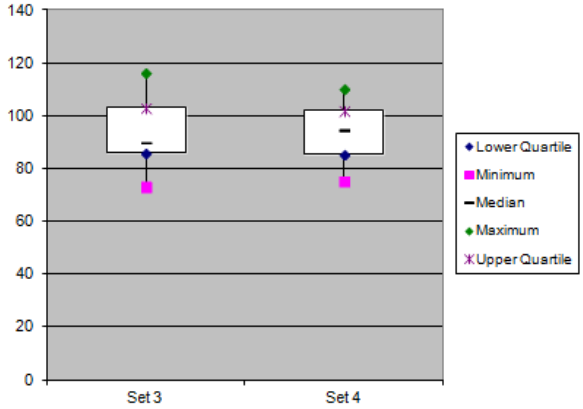
Attendance: The percentage of lessons attended by each student for each of the periods of the research.

Questionnaires and interview sheets are shown in appendix III.

Chapter 9: RESULTS

Background / contextual information

YELLIS Verbal

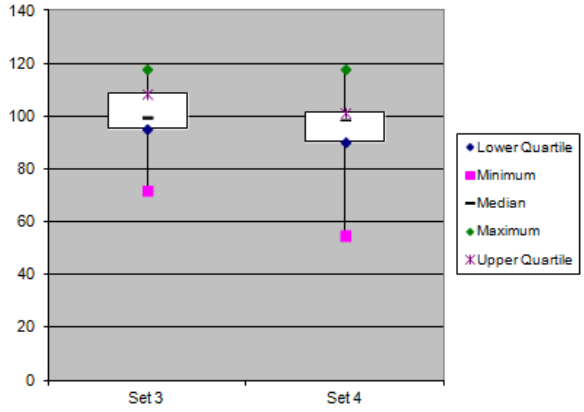


Set 3		Set 4	
Maximum	116	Maximum	110
Upper Quartile	103	Upper Quartile	102
Median	90	Median	95
Lower Quartile	86	Lower Quartile	85.75
Minimum	73	Minimum	75
Mean	93.2	Mean	93.3

Comparisons	
Highest median	Set **4**
Highest mean	Set **4**

Kruskal–Wallis test	
H	0.007
p	0.9337

YELLIS Non-Verbal

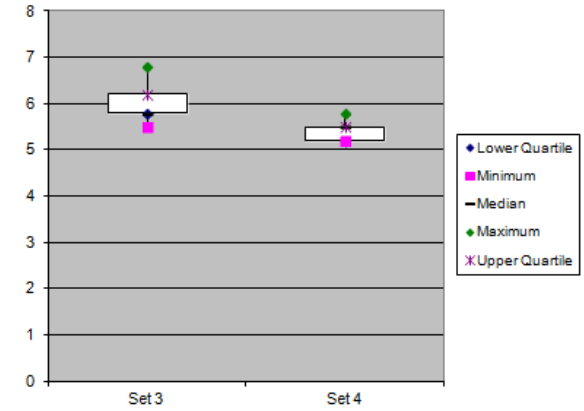


Set 3		Set 4	
Maximum	118	Maximum	118
Upper Quartile	108.5	Upper Quartile	101.5
Median	100	Median	99
Lower Quartile	95.25	Lower Quartile	90.5
Minimum	72	Minimum	55
Mean	100.7	Mean	94.8

Comparisons	
Highest median	Set **3**
Highest mean	Set **3**

Kruskal–Wallis test	
H	0.914
p	0.339

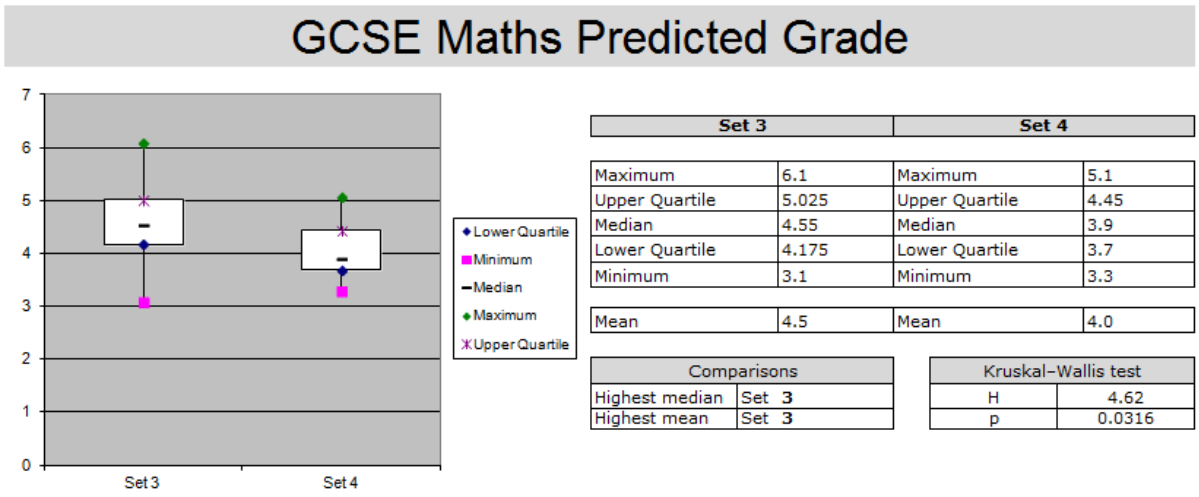
Recent School Assessment



Set 3		Set 4	
Maximum	6.8	Maximum	5.8
Upper Quartile	6.2	Upper Quartile	5.5
Median	5.8	Median	5.5
Lower Quartile	5.8	Lower Quartile	5.2
Minimum	5.5	Minimum	5.2
Mean	6.0	Mean	5.5

Comparisons	
Highest median	Set **3**
Highest mean	Set **3**

Kruskal–Wallis test	
H	15.892
p	0.0001



Set 3		Set 4	
Maximum	6.1	Maximum	5.1
Upper Quartile	5.025	Upper Quartile	4.45
Median	4.55	Median	3.9
Lower Quartile	4.175	Lower Quartile	3.7
Minimum	3.1	Minimum	3.3
Mean	4.5	Mean	4.0

Comparisons	
Highest median	Set 3
Highest mean	Set 3

Kruskal–Wallis test	
H	4.62
p	0.0316

	Set 3	Set 4	Higher	Stat Sig (5%)
YELLIS verbal	93.2	93.3	set 4	No
YELLIS non-verbal	100.7	94.8	set 3	No
Recent school assess	6.0	5.5	set 3	Yes
GCSE predict	4.5	4.0	set 3	Yes
Boys	75%	70%	set 3	
Pupil premium	25%	40%	set 4	
EAL	20%	15%	set 3	

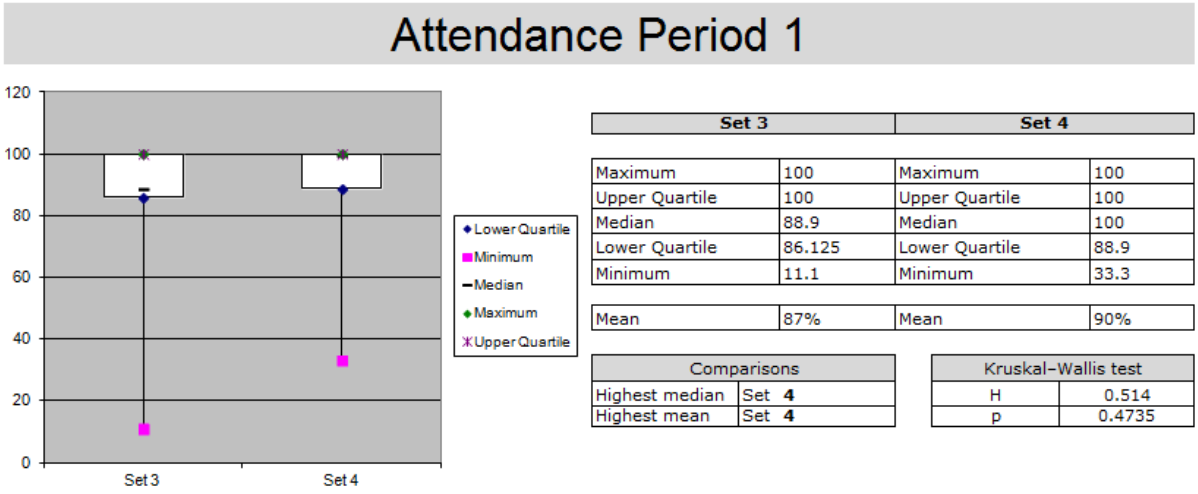
Considering the YELLIS verbal score, there is very little difference between the two groups, with set 4 being, in fact, slightly higher than set 3. On the non-verbal scores, set 3 is higher than set 4, the difference being far greater than for the verbal; however, this is still not statistically significant (at 5% K-W). The non-verbal is a better predictor of success in maths than the verbal is.

However, looking at the most recent school assessments (March 2015) and the GCSE maths predictor (from YELLIS), the scores for set 3 are significantly ahead ($p < 0.05$ on the K-W test) in each case, this difference amounting to approximately half a grade.

There are slightly more boys in set 3, slightly more EAL and significantly lower Pupil premium. In this school, the demographic has shown that boys, pupil premium and EAL do **not** generally perform differently to the rest of the school population, so this information is provided just as background.

This information is clearly showing that set 3 is out-performing set 4 in maths exams and the students have higher predictors (with statistical significance), even though their actual verbal and non-verbal scores are not significantly different.

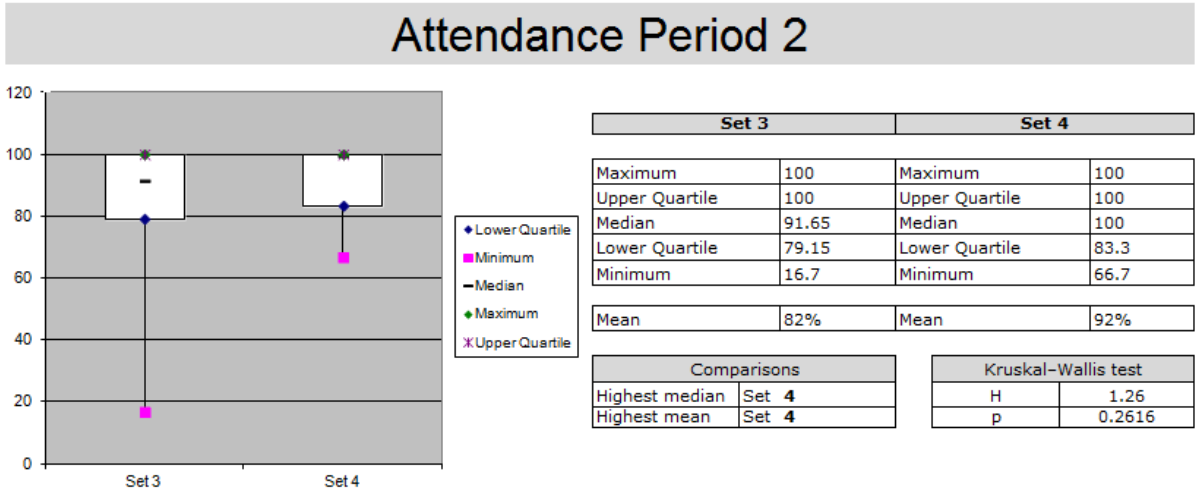
Attendance



Set 3		Set 4	
Maximum	100	Maximum	100
Upper Quartile	100	Upper Quartile	100
Median	88.9	Median	100
Lower Quartile	86.125	Lower Quartile	88.9
Minimum	11.1	Minimum	33.3
Mean	87%	Mean	90%

Comparisons	
Highest median	Set **4**
Highest mean	Set **4**

Kruskal–Wallis test	
H	0.514
p	0.4735



Set 3		Set 4	
Maximum	100	Maximum	100
Upper Quartile	100	Upper Quartile	100
Median	91.65	Median	100
Lower Quartile	79.15	Lower Quartile	83.3
Minimum	16.7	Minimum	66.7
Mean	82%	Mean	92%

Comparisons	
Highest median	Set **4**
Highest mean	Set **4**

Kruskal–Wallis test	
H	1.26
p	0.2616

	Set 3	Set 4	Higher
Period 1	87%	90%	set 4 by 3%
Period 2	82%	92%	set 4 by 10%
Total for year	91%	92%	set 4 by 1%

NB The set studying the adapted curriculum is shaded green, the un-adapted curriculum red
In the third column yellow shading indicates that the adapted curriculum out-performs the un-adapted curriculum
This convention is used in the following tables too

During both topics, the attendance of set 4 was higher than set 3. However, the attendance during the second topic (when set 4 was studying the enhanced curriculum) was higher as attendance in that set had risen while that in set 3 had dropped. In neither of these periods was the difference in attendance statistically significant according to the 5% confidence limit of the Kruskal-Wallis test.

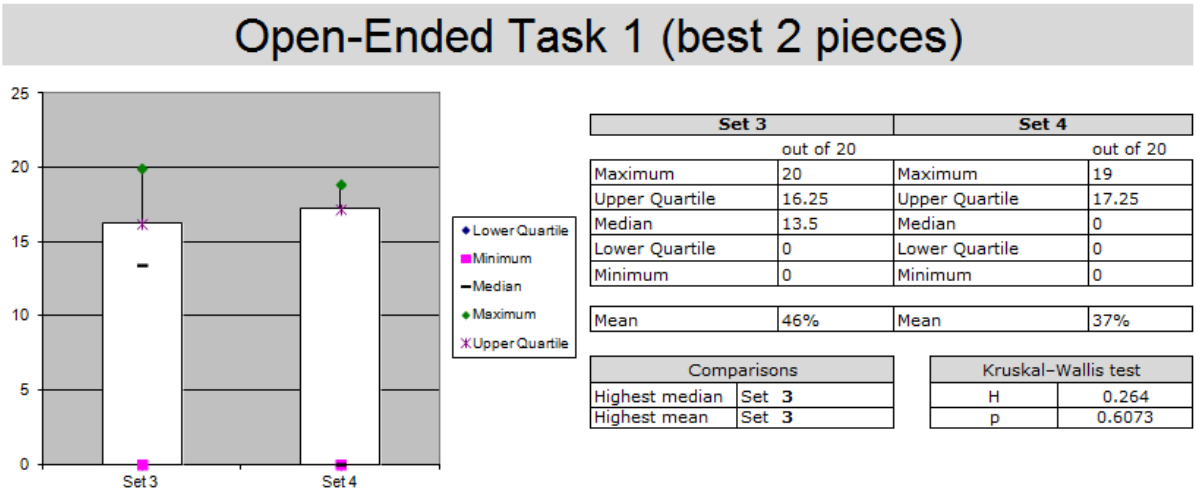
Open-ended Tasks

Two open-ended assignments were set, one for each topic. These were common to both sets.

In the first assignment, set 3 had been studying the enhanced curriculum. This class had a significantly higher completion rate for the tasks than set 4. The class also scored more highly on 2 out of the 3 tasks. The mean score for the task was higher for set 3 than set 4.

There were a significant number of non-submissions (leading to a score of zero) and this accounts for the median of set 4 being zero.

There is no statistical significance for the difference between the two classes and the number of non-submissions calls into question the validity of numerical comparison between the means and the medians. However, in a study of motivation, a comparison of the number of non-submissions does provide interest.



Set 3		Set 4	
	out of 20		out of 20
Maximum	20	Maximum	19
Upper Quartile	16.25	Upper Quartile	17.25
Median	13.5	Median	0
Lower Quartile	0	Lower Quartile	0
Minimum	0	Minimum	0
Mean	46%	Mean	37%

Comparisons	
Highest median	Set 3
Highest mean	Set 3

Kruskal–Wallis test	
H	0.264
p	0.6073

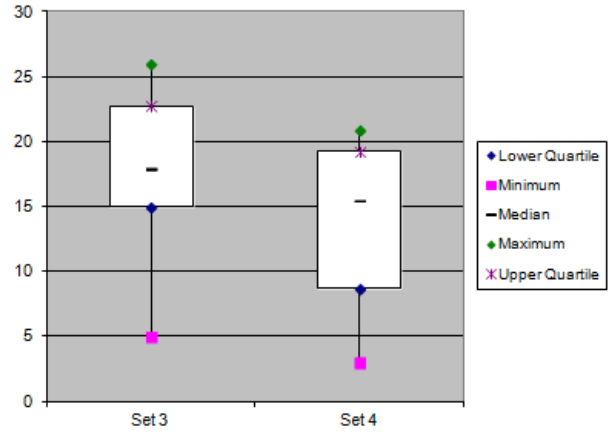
In the second assignment, set 4 had been studying the enhanced curriculum. This class had a very much higher completion rate for the tasks (with set 3 showing almost no willingness to complete the task at all). The completion rate for set 4 was also lower than it had been for the first assignment. This may show that the motivation of both classes deteriorated between the first and second assignment, possibly as a result of the approach of the end of the term and the end of exams. However, this effect was more noticeable in set 3 which studied the un-adapted curriculum.

The gaps in the data make a detailed analysis for the second assignment impossible.

	Set 3	**Set 4**	**Higher**
Number assignment			
Complete 1 or more tasks	60%	45%	set 3
Complete 2 or more tasks	55%	40%	set 3
Score task 1	83%	98%	set 4
Score task 2	63%	40%	set 3
Score task 3	86%	80%	set 3
Best 2 HW scores (includes zeros)	46%	37%	Set 3
Shape assignment			
Complete 1 or more tasks	5%	45%	set 4
Complete 2 tasks	0%	25%	set 4
Score task 1	50%	60%	set 4
Score task 2	0%	62%	set 4

Assessments

Assessment 1 Questions Attempted

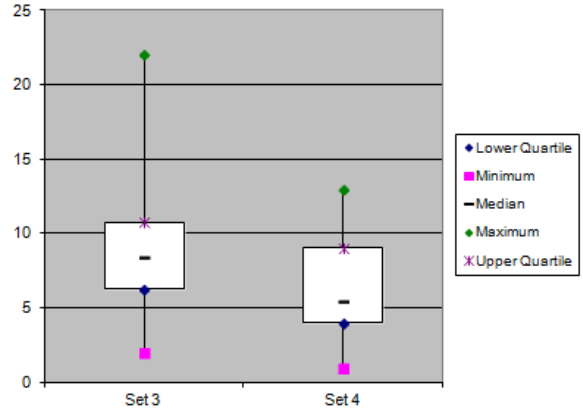


Set 3		Set 4	
	out of 27		out of 27
Maximum	26	Maximum	21
Upper Quartile	22.75	Upper Quartile	19.25
Median	18	Median	15.5
Lower Quartile	15	Lower Quartile	8.75
Minimum	5	Minimum	3
Mean	65.6%	Mean	51.9%

Comparisons	
Highest median	Set 3
Highest mean	Set 3

Kruskal–Wallis test	
H	2.117
p	0.1457

Assessment 1 Questions Correct



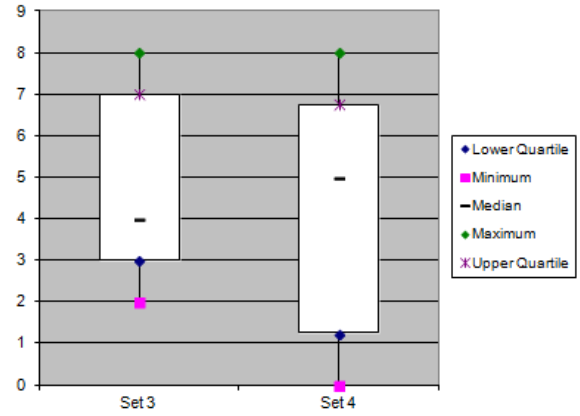
Set 3		Set 4	
	out of 27		out of 27
Maximum	22	Maximum	13
Upper Quartile	10.75	Upper Quartile	9
Median	8.5	Median	5.5
Lower Quartile	6.25	Lower Quartile	4
Minimum	2	Minimum	1
Mean	33.9%	Mean	24.1%

Comparisons	
Highest median	Set 3
Highest mean	Set 3

Kruskal–Wallis test	
H	2.43
p	0.119

For assessment 1 (number) in which set 3 had the adapted curriculum, the number of questions attempted and answers correct were both considered. On every measure (mean, median, maximum, minimum, upper and lower quartiles) set 3 out-performed set 4. The p-values were low (0.15 for the questions attempted and 0.12 for correct answers) but higher than the 0.05 required for statistical significance at 5%. However, since set 3 has higher YELLIS non-verbal scores, higher maths GCSE predictors and higher performance in recent tests, it cannot be said that the adjusted curriculum has caused this difference in performance.

Assessment 2 Questions Attempted

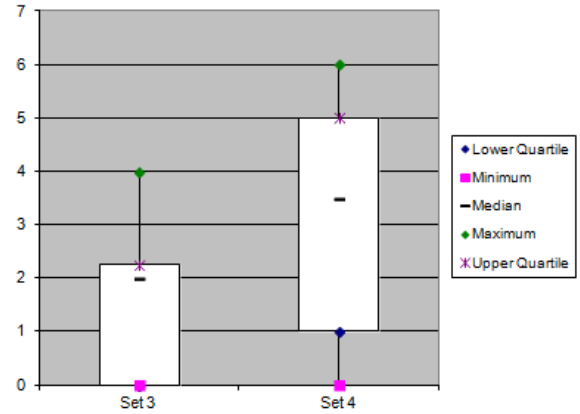


Set 3		Set 4	
	out of 8		out of 8
Maximum	8	Maximum	8
Upper Quartile	7	Upper Quartile	6.75
Median	4	Median	5
Lower Quartile	3	Lower Quartile	1.25
Minimum	2	Minimum	0
Mean	61.5%	Mean	51.8%

Comparisons	
Highest median	Set **4**
Highest mean	Set **3**

Kruskal–Wallis test	
H	0.482
p	0.4875

Assessment 2 Questions Correct



Set 3		Set 4	
	out of 8		out of 8
Maximum	4	Maximum	6
Upper Quartile	2.25	Upper Quartile	5
Median	2	Median	3.5
Lower Quartile	0	Lower Quartile	1
Minimum	0	Minimum	0
Mean	19.8%	Mean	37.5%

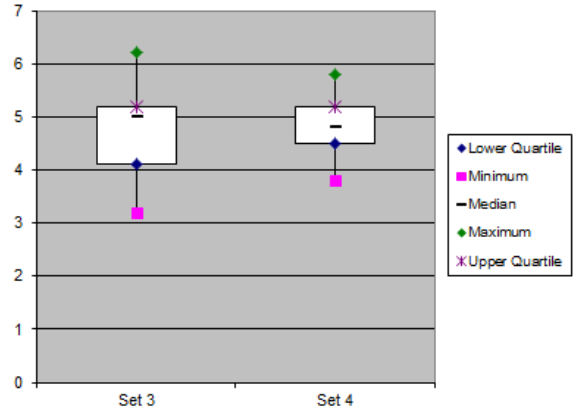
Comparisons	
Highest median	Set **4**
Highest mean	Set **4**

Kruskal–Wallis test	
H	2.225
p	0.1358

For assessment 2 (shape) in which set 4 had the adapted curriculum, the number of questions attempted and answers correct were both considered. For questions attempted, the picture is mixed: set 4 has the higher median while set 3 has the highest mean; set 4 has a greater spread. There is no statistical significance to any of these differences. However, on the measure of questions answered correctly, set 4 has both the higher mean and median (as well as all the other measures). It is therefore clear to see that set 4 has out-performed set 3 on this measure. The p-value of the Kruskal-Wallis test is low (0.14) but this is still not significant at 5%.

	Set 3	**Set 4**	**higher**
Number assessment			
Attempted	66%	52%	set 3
Correct	34%	24%	set 3
Shape assessment			
Attempted	62%	52%	set 3
Correct	20%	38%	set 4

Mock exam - mid-way through research

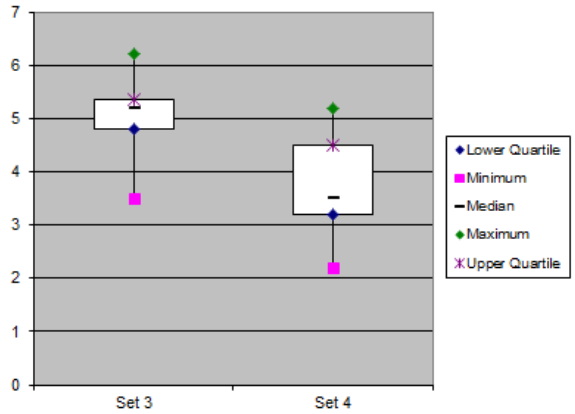


Set 3		Set 4	
	out of 8		out of 8
Maximum	6.2	Maximum	5.8
Upper Quartile	5.2	Upper Quartile	5.2
Median	5	Median	4.8
Lower Quartile	4.1	Lower Quartile	4.5
Minimum	3.2	Minimum	3.8
Mean	4.7	Mean	4.9

Comparisons	
Highest median	Set **3**
Highest mean	Set **4**

Kruskal–Wallis test	
H	0.002
p	0.9676

Exam autumn 2015 - after research finished



Set 3		Set 4	
	out of 8		out of 8
Maximum	6.2	Maximum	5.2
Upper Quartile	5.35	Upper Quartile	4.5
Median	5.2	Median	3.5
Lower Quartile	4.8	Lower Quartile	3.2
Minimum	3.5	Minimum	2.2
Mean	5.0	Mean	3.8

Comparisons	
Highest median	Set **3**
Highest mean	Set **3**

Kruskal–Wallis test	
H	17.763
p	0

Half way through the research, the classes took their end-of-year mock exams. By this point, set 3 had studied the complete *number* topic with the *adapted* curriculum, whereas set 4 had studied it with the *un-adapted* curriculum. The GCSE results are tabulated above using the code A*=8, A = 7, etc as before. *In this mock exam, set 4 appears to have "caught up" with set 3.* The mean of set 4's results is higher than the mean of set 3's, although the median of set 3's results is higher. In both cases, these figures are very close, and there is no statistical significance.

There was no exam after the research period had finished, but there was one early in the following term. Several students changed sets, but the results for individuals have been gathered and linked with their original sets. By this point, both sets had studied a topic with the adapted curriculum and another with the un-adapted curriculum. In this set of exams, set 3 has moved ahead again. The mean and median are both higher than set 4 and there is statistical significance in this difference.

The combination of these results shows that, based entirely on whole-school maths exams, involving a much wider range of topics than those in this study, those studying the un-adapted *curriculum showed improved maths results*.

There are, of course, many other factors. The exams would have contained a wide range of material, certainly not limited to the topics taught during the period of the research. There is also the question of the time delay between the end of the research and the year 11 mock exam (including the whole of the summer holidays).

Pupil questionnaires

Analysis 1

In the first instance, an analysis has been conducted on the questionnaires which *compare the two sets in each of the two topics*:

	Topic 1						Topic 2					
	Set 3	Set 4	set 3-set 4	Higher	K-W H	K-W p	Set 3	Set 4	set 3-set 4	Higher	K-W H	K-W p
How interesting was this topic?	2.53	2.63	-0.09	4	0.047	0.828	2.24	2.11	0.12	3	0.070	0.792
How well taught was this topic?	3.20	3.13	0.08	3	0.479	0.489	2.56	2.83	-0.27	4	0.096	0.756
How easily could you do the work within this topic?	2.87	2.44	0.43	3	2.691	0.101	2.59	2.44	0.14	3	0.315	0.575
How useful will this topic be for future life and work?	3.00	2.80	0.20	3	0.248	0.619	2.56	2.44	0.12	3	0.086	0.769
How well have you developed specific skills	3.13	2.40	0.73	3	5.299	0.021	2.24	2.47	-0.24	4	0.580	0.446
How much do you enjoy learning maths?	2.07	2.50	-0.43	4	1.314	0.252	2.35	2.28	0.08	3	0.002	0.965
How good do feel you are at this topic?	2.53	2.13	0.41	3	1.139	0.286	2.41	2.56	-0.14	4	0.170	0.680
Totals	**19.33**	**18.01**	**1.32**	**3**	**2.673**	**0.102**	**16.95**	**17.14**	**-0.19**	**4**	**0.016**	**0.900**

NB For the totals row, the Kruskal-Wallis values have been calculated using all the data combined, not the totals for each student.

Topic 1, comparing set 3 with set 4

In 5 out of the 7 questions, set 3 (with the adapted curriculum) gave a higher score. When the total for topic 1 was considered, set 3 gave a higher combined score than set 4. *This shows that the set with the adapted curriculum had a more positive view of the lessons.*

Topic 2, comparing set 3 with set 4

In 4 out of the 7 questions, set 3 (with the **un**-adapted curriculum) gave a higher score. However, when considering the total for topic 2, set 4 gave a higher combined score than set 3. While this last result might be unexpected (set **3** students had higher scores in 4 out of the 7 questions), it may have come about through a bigger differential in scores when set 4 students were answering questions which favoured topic 2. *The totals show that the set with the adapted curriculum had a very slightly more positive view of the lessons.*

For the topic 1 total the p-value was 0.1 (statistically not significant at 5%) and for topic 2 the p-value was 0.9 (no significance at all).

Analysis 2

In the second instance, an analysis has been conducted which *compares the two topics for each of the two sets*:

	Set 3						Set 4					
	topic 1	topic 2	topic 1-topic 2	Higher	K-W H	K-W p	topic 1	topic 2	topic 1-topic 2	Higher	K-W H	K-W p
How interesting was this topic?	2.53	2.24	0.30	1	0.599	0.439	2.63	2.11	0.51	1	3.096	0.079
How well taught was this topic?	3.20	2.56	0.64	1	2.756	0.097	3.13	2.83	0.29	1	1.257	0.262
How easily could you do the work within this topic?	2.87	2.59	0.28	1	0.343	0.558	2.44	2.44	-0.01	2	0.000	0.986
How useful will this topic be for future life and work?	3.00	2.56	0.44	1	1.139	0.286	2.80	2.44	0.36	1	0.953	0.329
How well have you developed specific skills	3.13	2.24	0.90	1	6.118	0.013	2.40	2.47	-0.07	2	0.029	0.865
How much do you enjoy learning maths?	2.07	2.35	-0.29	2	0.462	0.497	2.50	2.28	0.22	1	0.386	0.535
How good do feel you are at this topic?	2.53	2.41	0.12	1	0.080	0.777	2.13	2.56	-0.43	2	1.905	0.168
Totals	**19.33**	**16.95**	**2.38**	**1**	**5.402**	**0.020**	**18.01**	**17.14**	**0.88**	**1**	**1.064**	**0.302**

NB For the totals row, the Kruskal-Wallis values have been calculated using all the data combined, not the totals for each student.

Set 3, comparing topic 1 with topic 2

Set 3 gave higher scores to topic 1 (the adapted curriculum) in 6 out of the 7 cases, with one of these being statistically significant. When the totals were considered, set 3's total favoured topic 1 with statistical significance. *This shows that set 3 were far more positive about the learning with the adapted curriculum.* There can, of course, be other reasons to be more positive about the penultimate period of work in the summer term than the final piece.

Set 4, comparing topic 1 with topic 2

Set 4 gave higher scores to topic 1 (the **un**-adapted curriculum) in 4 out of the 7 cases. The total score also favoured topic 1. The gap between the scores for the two topics was much smaller than in set 3 and there was no statistical significance in any of set 4's results.

These two sets of results suggest that, if there is a drop-off in motivation towards the end of term, the adapted curriculum may have reduced this.

Teacher questionnaires

Questionnaires were completed by the teachers of both groups at the end of each topic. Each question was answered on a scale of 1 (minimum) to 4 (maximum). The answers are summarised in the tables below:

		Topic 1				Topic 2			
		Set 3	Set 4	set 3-set 4	Higher	Set 3	Set 4	set 3-set 4	Higher
1	How interesting do you think students found this topic?	3	3	0.00	0	3	4	-1.00	4
2	How well do you think you taught this topic?	2	3	-1.00	4	2	3	-1.00	4
3	How easily could the students do the work in this topic?	2.5	3	-0.50	4	2.5	3	-0.50	4
4	How useful will this topic be for the students' future life and work?	4	3	1.00	3	2.5	4	-1.50	4
5	How well have they developed specific skills in this topic?	2	2	0.00	0	3	3	0.00	0
6	How much did you enjoy teaching this topic?	1	1	0.00	0	3	4	-1.00	4
7	How good was the quality of the students' work in this topic?	2	2	0.00	0	2	3	-1.00	4
8	How good was the quantity of the students' work in this topic?	1	4	-3.00	4	0	2	-2.00	4
9	How good was the students' engagement in this topic?	2.5	3	-0.50	4	2	4	-2.00	4
10	How good was the students' attitude in this topic?	2	3	-1.00	4	3	4	-1.00	4
11	How pleased were you with the amount of work covered in this	2	3	-1.00	4	1	3	-2.00	4
	Totals	**24**	**30**	**-6**	**4**	**24**	**37**	**-13**	**4**
	Kruskall- Wallis	**H**	**3.028**	**p**	**0.0818**	**H**	**7.973**	**p**	**0.0047**

Analysis 1

In the first instance, an analysis has been conducted on the questionnaires which *compare the two sets in each of the two topics*:

Topic 1, comparing set 3 with set 4

In 5 of the 11 questions, the teacher of set 3 (adapted curriculum) gave a higher score compared with 6 of the 11 where the teacher of set 4 had the higher score. The totals also gave a higher score to set 4. It was not statistically significant at 5%.

Topic 2, comparing set 3 with set 4

In 10 of the 11 questions, the teacher of set 4 (the adapted curriculum) gave a higher score; in the remaining 1 question, they were equal. The totals also demonstrated a much higher score for set 4. *The difference between the two sets of scores was statistically significant.*

These two pieces of analysis show that the set 3 teacher has reported more negatively than the set 4 teacher for both pieces of work. *However, it is much more negative during the un-adapted curriculum than during the adapted curriculum (statistically significant at 5%).* However, it may also show that set 3 have a more pronounced drop off in motivation towards the end of term than set 4.

Analysis 2

In the second instance, an analysis has been conducted which *compares the two topics for each of the two sets*:

		Set 3				Set 4			
		topic 1	topic 2	topic 1-topic 2	Higher	topic 1	topic 2	topic 1-topic 2	Higher
1	How interesting do you think students found this topic?	3	3	0	0	3	4	-1	2
2	How well do you think you taught this topic?	2	2	0	0	3	3	0	0
3	How easily could the students do the work in this topic?	2.5	2.5	0	0	3	3	0	0
4	How useful will this topic be for the students' future life and work?	4	2.5	1.5	1	3	4	-1	2
5	How well have they developed specific skills in this topic?	2	3	-1	2	2	3	-1	2
6	How much did you enjoy teaching this topic?	1	3	-2	2	1	4	-3	2
7	How good was the quality of the students' work in this topic?	2	2	0	0	2	3	-1	2
8	How good was the quantity of the students' work in this topic?	1	0	1	1	4	2	2	1
9	How good was the students' engagement in this topic?	2.5	2	0.5	1	3	4	-1	2
10	How good was the students' attitude in this topic?	2	3	-1	2	3	4	-1	2
11	How pleased were you with the amount of work covered in this	2	1	1	1	3	3	0	0
	Totals	**24**	**24**	**0**	**0**	**30**	**37**	**-7**	**2**
	Kruskall- Wallis	**H**	**0.276**	**p**	**0.5994**	**H**	**3.028**	**p**	**0.0818**

Set 3, comparing topic 1 with topic 2

In 4 of the 11 questions, topic 1 scored more highly; in 4 questions they were equal; in 3 questions topic 2 scored more highly. The totals showed no difference and there was no statistical significance in any of the differences.

Set 4, comparing topic 1 with topic 2

In 1 of the 11 questions topic 1 scored more highly; in 3 questions they were equal; in 7 questions topic 2 scored more highly. *This shows that the set 4 teacher has observed effects which could be linked to better motivation during the period of the adapted curriculum.* The p-value was 0.08 but was not statistically significant.

Since each of these surveys is completed by one individual only, their statistical value will be limited, but they still demonstrate some interesting patterns.

Pupil comments

Set 3, Topic 1 (adapted curriculum)

11 students mentioned that the topic would be valuable for future life (and in some cases gave examples). 3 students mentioned that this topic had specifically been better at preparing for real life. 2 students said that it would be better if it the lessons had been more practical.

5 students said that they had found the lessons different, giving reasons such as the video, collaborative working, worksheets and the teacher. [NB The practical tasks were by their nature slightly collaborative, but the lessons were not designed specifically to be collaborative. There were a few occasions when the teacher was different – see "confounding variables".]

No-one said that this topic was harder or worse than normal topics.

Set 3, Topic 2 (un-adapted curriculum)

9 students mentioned aspects of the lesson which had been to do with real life, in some cases giving examples. No-one said that this series of lessons had been particularly practical. One said that the lessons had been too theoretical and one declared that maths would not be useful for future life.

4 students said they had found the lessons different and better, citing reasons such as it being easier, use of worksheets and in one case more useful.

5 students said that this topic had been worse or harder.

Set 4, Topic 1 (un-adapted curriculum)

7 students mentioned that maths would be useful for their future life and work with a variety of reasons relating to the topics covered.

1 of these said that the lessons had been different (better) because of collaborative work.

3 students said that they had not enjoyed the topic or found it hard.

Set 4, Topic 2 (adapted curriculum)

5 students mentioned aspects of the topics which would be useful in later life and work.

9 students (including one of the above) said that they had preferred this topic. Very few reasons were given; they included that it was easier to understand or more interesting.

3 students said this topic was harder or worse.

	Set 3	**Set 4**	**Higher**
Number assignment			
Useful for future life or work	11	7	Set 3
Lessons were different and better	5	1	Set 3
Lessons were worse	0	3	Set 4
Shape assignment			
Useful for future life or work	9	5	Set 3
Lessons were different and better	4	9	Set 4
Lessons were worse	5	3	Set 3

In the first assignment, the *set studying the adapted curriculum displayed significantly more positive comments and fewer negative comments*. They also made *marginally more comments that the material would be useful in future life and work*. [It must be stated that this question is specifically asked and therefore a high rate of return is to be expected.]

In the second assignment, the *set studying the adapted curriculum made more positive comments and fewer negative comments*, although these figures were not as far apart as they were for the first

task. The one figure which bucks the trend is that *students studying the **un-adap**ted curriculum made more comments that the material would be useful in future life and work*.

Teacher questionnaires and lesson observations

The teachers' comments are recorded in Appendix III.

Teachers commented on the way in which their classes engaged with the work. Since the teachers were aware of the project, its methodology and its purpose, it would be impossible for them to make an unbiased and objective judgement on whether one block of work was more successful than the other.

A direct, numerical comparison of the lessons cannot be usefully undertaken for all lessons because:

- There is no objective baseline (ie what are lessons "usually" like?)
- The lesson material has not been planned by the teacher and hence any judgement on this is irrelevant
- OFSTED judgements (on a scale of 1-4) are quite blunt instruments
- The material in each of the classes is different for the adapted and un-adapted curriculum and therefore direct comparison between the atmosphere in the lessons is not necessarily useful.

The most useful comparisons are when the classes are doing the same work. On the following two occasions the two classes were doing the same work and the researcher was able to move between the two classes and make judgements on how they were working relative to each other.

Topic 1, lesson 5, 10th June 2015

Both teachers present, classes in adjacent computer rooms.

Task: working on BBC bite-size revision of the topic; beginning the open-ended task

At the start of each of these lessons, an introduction was given by both the regular teacher and the researcher so that there was clarity and uniformity with the instructions.

	Set 3 (adapted curriculum)	Set 4 (un-adapted curriculum)
Engagement	Very good engagement with both tasks. A little communication, but only to do with the work.	Very good engagement. No off-task behaviour observed at all.
Ability to complete tasks	There seemed to be good recollection of material studied and therefore the ability to engage with the revision activities. With a small amount of assistance, the open-ended tasks were started.	Reasonable recollection of the work done over the last few weeks. Ability to do the majority of the revision work. Open-ended task needed some additional explanation.
Independent work	A reasonable amount of independent work, although the research for the open-ended tasks was a little outside the comfort zone.	Some difficulty starting on the open-ended task. Required some explanation of how to use the resources. However, motivated to succeed.
Quality of outcome	Revision: good work. Open-ended task: quite a slow start but the beginnings of good work.	Revision: good work. Most activities successful with a little teacher prompting. Help required with the open-ended task.

Topic 2, lesson 5, 16th July 2016

Both teachers away, supply teachers appointed for each of the classes and they were located in adjacent computer rooms.

Task: continue with open-ended task 2.

The researcher gave the introduction to each class.

	Set 3 (un-adapted curriculum)	Set 4 (adapted curriculum)
Engagement	Generally good engagement. Most students on task for most of the lesson. Some chatting between students who needed to be brought back into line. Some collaboration even though this was an independent task.	Good engagement throughout the lesson. Most students on task for the whole lesson. Some communication between students but generally this was within the task.
Ability to complete tasks	Extremely variable. The ability to link even a simple theoretical calculation (eg area of a rectangle) to a practical task proved to be tricky. Conversion of units caused further confusion.	Variable. Some had created designs which made the calculations difficult, hence few had useful tables of values which were complete.
Independent work	Limited independent work. While students were happy to design their own apartments, they were less able and/or	While the students were happy to engage in the design task and work on their own, I did not see enough of the research into the

	willing to start the calculations needed. Very few got onto the tabulated values.	prices of the flooring. Hence, even if the designs could be finished, few had made enough progress to complete the tables.
Quality of outcome	Some designs were produced which displayed care and creativity. However, the calculations which needed to sit on top of these designs were slow to come, often inaccurate and rarely followed up with the research on flooring costs. Reluctance to download the table template in order to complete this task.	Some very good designs. With some prompting the students downloaded the calculation template and began to fill it in. Some assistance needed with the calculations.

From analysis of the above notes, it appears that:

- There was good engagement from both classes in the task. No noticeable difference in the two classes.
- In topic 1, set 3 was able to complete the tasks better than set 4. In topic 2, there appeared to be little difference in the class' ability to complete the work.
- In topic 1, set 3 was able to work independently more than set 4. In topic 2, both classes were able to create their designs independently and both were slightly reluctant to move to the research, calculation and tabulation exercise.
- In topic 1, the quality of outcome was better for set 3. In topic 2, the quality of outcome was better for set 4.

Change in rank: which students change most over the course of the study

The results in this section are not designed to evaluate overall class shifts for two reasons. First of all, this has been done in earlier analyses. Secondly, this part of the study is using ranks within each class and therefore there will be a zero sum gain. The aim is purely to identify which students have been more affected by the work and whether there are factors which may have led some of these students to be thus affected.

NB in all cases the students are referred to in masculine form. This is to preserve anonymity as there are relatively few girls in the samples.

Set 3

Student 302: He ranked 18, 19, 11. This meant that there was a large positive shift over the second period of work (the un-adapted curriculum) and hence overall. His questionnaire showed 2 for all except for *interest* and *enjoyment* for the first period and entirely 1 for the second period. Comments included "pointless" and none of it being useful or interesting. He could sense no difference in the way either topic had been taught. For the questions *how easily could you do the work* and *how good are you at this topic* there were low scores for both topics. **It is very difficult to create meaning from this data.**

Student 304: He ranked 10, 16, 6. This meant that there was a large positive shift over the second period of work (with the un-adapted curriculum). His questionnaire showed a mixed range of responses for topic 1, the most positive being *usefulness* which was given 4. There was a similarly mixed response for topic 2, with no scores of 4, and the *usefulness* score being blank. Very little response in the questionnaire for topic 1, but in the interview commented that the topic had been better taught. Topic 2 was highlighted as being more engaging and more relevant to future life. For the questions *how easily could you do the work* and *how good are you at this topic* there were high scores for both topics. **The link here is that the topic seen as more relevant to future life produced the better impact. However, this was not the adapted curriculum.**

Student 307: He ranked 3, 11, 11. This meant that there was a large negative shift over the first period of work (the adapted curriculum) which was maintained overall. There were no questionnaires completed and this student was absent from both interviews. **Not useful data from this.**

Student 309: He ranked 3, 3, 18. This meant that there was a very large negative shift over the second period of work (with the un-adapted curriculum)and hence overall. In the first topic, all questions were scored 3 apart from *usefulness for future life* (which scored 2). He commented that maths should be for future life but could sense no difference in the way the topic had been taught. Topic 2 also has scores of 2 and 3 (*usefulness for future life* was a 3); he said that the topic would be useful for architecture but felt that topic 1 was better. **Topic 1 has not positively influenced this student but he does identify that maths *should* be useful and relevant.**

Student 310: he ranked 10, 3, 11. This meant a slightly positive shift over the first period of work (adapted curriculum) and a negative shift over the second period of work, leading to very little change overall. Topic 1 was ranked with 1, 2 or 3 with some application being identified in the questionnaire. Very similar responses were given for topic 2. Expressed a preference for topic 1. For the questions *how easily could you do the work* and *how good are you at this topic* there were mixed scores for both topics. **There is some evidence here that the student recognised relevance in the work (topic 1) with some improvement in results.**

Student 315: He ranked 10, 3, 2. This meant that there was a positive shift over the first period of work (adapted curriculum) leading to a large positive shift overall. Topic 1 was ranked 1, 2 or 3 with some relevance identified. Topic 2 was given ranks entirely of 1. Some relevance for the topic was identified but the student said that useful methods had not been taught in lessons. **This student attained a better result on the topic he could see as relevant to future life but did not recognise that work from the lessons.**

Student 318: He ranked 10, 15, 6. This meant that there was a large positive shift over the second period of work (with the un-adapted curriculum). Topic 1 was scored 2, 3 or 4 with several aspects identified as being relevant for future life. Topic 2 had similar scores and comments. **This student has identified the relevance of topic 1 but it has failed to influence his performance.**

Set 4

Student 404: He ranked 1, 2, 9. This meant a negative shift over the second period of work (un-adapted curriculum), leading to a large negative shift overall. Topics 1 was grades 2, 3 and 4; no relevant comments were made on the questionnaire and he missed the interview. This student

failed to complete the questionnaire for topic 2 but described the topic as useful. **The missing data makes this student's results difficult to use.**

Student 407: He ranked 1, 9, 10. This meant that there was a large negative shift over the first period (un-adapted curriculum) and overall. Topic 1 was graded 2, 3 and 4 including 4 for *usefulness for future life and work* although no relevance was mentioned in either the questionnaire or interview. Similar scores and comments were given for topic 2. **The similarity of questionnaire scores for both topics make this student's results of limited value.**

Student 412: He ranked 1, 9, 19. This meant that there was a large negative shift over both the first (adapted curriculum) and second (un-adapted curriculum) periods leading to a very large overall negative shift. Topic 1 was graded 2, 3 and 4 including 4 for *usefulness for future life and work* although no relevance was mentioned in either the questionnaire or interview (in fact very little said at all). Similar scores and comments were given for topic 2. **The similarity of questionnaire scores for both topics make this student's results of limited value.**

Student 414: he ranked 1, 9, 10. This meant that there was a large negative shift over the first period (un-adapted curriculum) and hence overall. Topic 1 was graded 1, 2 and 3 including 1 for *usefulness for future life and work* and no relevance was mentioned in the questionnaire and interview was missed. Similar scores and comments were given for topic 2. For the questions *how easily could you do the work* and *how good are you at this topic* there were high scores for both topics. **The similarity of questionnaire scores for both topics make this student's results of limited value.**

Student 415: He ranked 4, 1, 10. This meant that there was a large negative shift over the second period (adapted curriculum) and hence overall. Topic 1 was scored 2, 3 and 4 with application in future life mentioned in the comments. Topic 4 was scored more generously (all 3s) with positive comments but nothing about application in future life or work. For the questions *how easily could you do the work* and *how good are you at this topic* there were high scores for both topics. **While this student appears to regard the adapted curriculum topics more highly, his results have gone down over this period.**

Student 416: He ranked 12, 9, 2. This meant small positive shifts over both periods leading to a large positive shift overall. Topic 1 scored all grade 3 apart from *usefulness for future life and work* which scored 4; no relevant comments were made in the questionnaire and this student missed his interview. Topic 2 scored all 3s apart from a 2 and a 4. For the questions *how easily could you do the work* and *how good are you at this topic* there were high scores for both topics. No comments in either the questionnaire or survey about usefulness. **This student gave the top grade for *usefulness for life and work* over the period studying the un-adapted curriculum. There was a small positive shift in results during this time.**

Student 417: He ranked 12, 15, 20. This meant small negative shifts over both periods leading to a large negative shift overall. Topic 1 was scored 1, 2 and 3 (*usefulness for future life and work* being 3) with several comments made in the interview of the applicability of the material to use in business. Topic 2 scored more highly (most 3 with a few 2s); no comments were made on the questionnaire and this student missed his interview.

Student 421: He ranked 12, 19, 4. This meant a small negative shift in the first half (un-adapted curriculum) followed by a large positive shift in the second half (adapted curriculum) leading to a

large positive shift overall. Topic 1 scored 1, 2 and 3. *Usefulness for future life and work* scored 2, no comments were made on the questionnaire about applicability of the material and this student missed his interview. Topic 2 scored all 2s with 2 3s. No comments were made in the questionnaire and no mention was made about usefulness in the interview. **This student increased his rank during the period of the adapted curriculum but scored *usefulness for life and work* quite low.**

Where highlighted in green, the adapted curriculum has led to a positive shift; where highlighted in red, the adapted curriculum has led to a negative shift.

It is clear that there is **insufficient** evidence that those who have made the biggest movements (either positively or negatively) have been influenced by their perception of the relevance of that material to life and work, and no evidence that the adapted curriculum has made an impact on those movements. For this to have been the case, it would have been expected that the *relevance to future life and work* would be high score on adapted curriculum topic, while being low on the un-adapted curriculum topic. For the case to be made that this impacted positively on academic outcomes, the **relative** improvement in rank would need to have occurred during the adapted topic (this could either have been an improvement in rank during the adapted topic or a decrease in rank during the un-adapted topic).

For future study, more detailed attitudinal surveys, including several which specifically relate to the applicability of the curriculum, should be used, along with questions which attempt to identify students' motivation more generally. It would be particularly interesting to know whether those with a pre-existing mastery mindset or a performance mindset are more influenced by changes to the curriculum, or whether the curriculum is able to influence those mindsets.

As is stated elsewhere, it must be noted that the end-point data (the September exam) is after the summer holiday and therefore a wide range of confounding factors may have come into play.

Chapter 10: CONCLUSION

Aims

This study considers the role which motivation plays in the performance of secondary school students. In particular it considers whether elements of the mathematics curriculum which contains external validation in the form of skills which are known to be of value in the future work-place or real life (ie the specific applicability of maths skills) will provide additional motivation and encourage school-age students to engage more with the work, spend more time on it and, consequently, achieve better results.

Therefore the aims are specifically to answer the following questions:

1 Does a specific link to work-place and real-life skills lead to better engagement in mathematics, more time being spent on task and consequently better results?
2 Are certain types of student more susceptible to these strategies?
3 Does learning linked specifically to skills for the work-place and real life tend to lead to a change in mindset, and is it a performance or a mastery mindset? How can this mindset be measured?
4 Have academy schools used the curriculum freedoms open to them to introduce motivational aspects to their teaching such as work-place learning?

Existing theories of motivation

Seifert (2004) summarises four theories of motivation:

Self-efficacy theory – the student's belief in his / her ability to complete a task which may in turn lead to better motivation (Bandura, 1977, 1993) and more of a mastery behaviour (see later). However, this theory does not account for students who do not wish to complete work or see any point in doing so. It is the attempt to unlock this motivation to attempt the task, and in particular whether the value of a skill in the future work-place is sufficient to do this, which is the subject of this study. It may be that this perception of self-efficacy might be *artificially* improved, and it may be that, where specific skills can be shown to be valuable in the work-place or the real world, the achievement of these skills may enhance students' self-belief.

Attribution theory – the placing of a student's ability to complete a task either within or outside the student's own control. As Dweck (1986) suggests, the former leads to a belief that effort or application will lead to success whereas the latter is more likely to lead to a belief in a fixed limit of ability.

Self-worth theory – the belief that a person's own value is dependent on his / her ability to achieve tasks (Covington 1984). This leads to a reluctance to take risks and to defend the student from the possibility of failure. Future success might be broadened from purely academic success to success in the work-place; this could mean that less academic students, who experienced success in the classroom which they know to be of value outside the classroom, might increase their self-worth.

Achievement goal theory, which, in turn, is sub-divided into learning and mastery goals (Ames and Archer, 1987). In much the same way as attribution theory, goal theory suggests that performance goals are more likely to be either within a student's power to change (being dependent on effort,

commitment etc) or outside it (being dependent on a fixed ability). Importantly, as Nichols (1984) describes, those with a performance goal mindset have a belief that learning is only a means to achieve a particular end rather than for increase in knowledge for its own sake. This study is based on the applicability of learning in future life and work and, therefore, might be encourage a performance goal mindset. Blumenfeld (1992), however, suggests that both performance and mastery goals may be enhanced simultaneously.

Brophy 2007 identifies a number of strategies for motivating students to learn. The three most relevant of these to this study are to:

- Call attention to the instrumental value of academic activities
- Induce task interest or appreciation
- Use task-related thinking and problem solving

There are a number of aspects of learning which enhance motivation and these may be enhanced when classroom learning includes skills which will be relevant in the future life. For example:

- Brophy (2004) and Wigfield and Eccles (1992) speak of "meaningful activities"
- Blumenfeld (1992)'s activities which are "relevant to the world outside"
- Brophy speaks of the necessity for "personal relevance" for a piece of learning to be motivating, and Toumlin (1972) and Pintrich et al (1993) speak about the use of skills and knowledge in the community and in real-world problems.

Main findings from this research

Note: "statistical significance" refers to the 5% confidence limit of the Kruskal-Wallis test in all cases.

Two maths sets (numbers 3 and 4 out of a total of 6, arranged by ability) were used for this study. As background, set 3 had:

- Higher YELLIS non-verbal scores (not statistically significant) – 100.7 compared to 94.8
- Higher maths GCSE predictor from YELLIS (statistically significant) – 4.5 compared to 4.0
- Higher internal assessments in maths from March 2015 (statistically significant) – 6.0 compared to 5.5

There were two periods of work – in the first period, set 3 studied the **adapted curriculum** (with specific mention of the value of the work in the future work-place and real life) while set 4 studied the **un-adapted curriculum**. In the second period, the two groups were reversed. In the first period, both sets studied the topic "number" while in the second they studied "shape".

A range of measures of performance were recorded:

Attendance

In the first period, set 4 had higher attendance by 3% whereas in the second period set 4 had higher attendance by 10%. Therefore, during both topics, the attendance of set 4 was higher than set 3. However, the attendance during the second topic (when set 4 was studying the enhanced curriculum) was significantly higher as attendance in that set rose while that in set 3 dropped. These differences are not statistically significant.

Evidence that the adapted curriculum improves motivation: the set studying the adapted curriculum maintained its high attendance compared to the other set whose attendance deteriorated in the second period.

Topic 2 was at the very end of the summer term (after mock exams) and hence attendance (along with motivation to work, etc) might have deteriorated for a number of reasons.

End-topic assessments

Assessments were conducted at the end of each of the two topics and were common to both sets.

Assessment 1: set 3 had the higher median and mean on both questions attempted and questions correct. This is not statistically significant.

Assessment 2: questions attempted set 4 had a higher median while set 3 had the higher mean (set 4 mean being brought down through a few zeros). For correct answers, set 4 has both higher median and mean.

Evidence that the adapted curriculum improves motivation: in the first assessment, the set studying the adapted curriculum out-performed the other set on both questions attempted and correct answers (using median and mean). In the second assessment the set studying the adapted curriculum scored more highly for correct answers (median and mean) and had a higher median for number of questions attempted.

Evidence* against *the adapted curriculum improving motivation: the set studying the adapted curriculum had a* lower *mean number of questions attempted in assessment 2.

Open-ended assignments

Each topic included one open-ended assignment, common to both sets, which used the skills and materials taught within the topic. The assignments were designed to allow an amount of flexibility in both the amount and quality of the work, and the quality and quantity of what was produced was analysed. The tasks were begun in lessons and completed at home.

In the number assignment, set 3 had a higher completion rate than set 4. The class also scored more highly on 2 out of the 3 tasks. The mean score for the task was higher for set 3 than set 4. There were a lot of non-submissions especially in set 4 which leading to a median of zero for this set.

- Completing 1 or more tasks: set 3 60%, set 4 45%
- Completing 2 or more tasks: set 3 55%, set 4 40%
- Score task 1: set 3 83%, set 4 98%
- Score task 2: set 3 63%, set 4 40%
- Score task 3: set 3 86%, set 4 80%
- Best 2 homework scores: set 3 46%, set 4 37%

In the shape assignment set 4 had a much higher completion rate than set 3 although both groups had a lower rate than on the previous assignment. This deterioration across the board may be accounted for by the imminence of the end of term and the fact that mock exams had finished.

- Completing 1 or more tasks: set 3 5%, set 4 45%
- Completing 2 tasks: set 3 0%, set 4 25%
- Score task 1: set 3 50%, set 4 60%
- Score task 2: set 3 0%, set 4 62%

The difference in scores in the first assignment is not statistically significant, and the gaps in the data make such a test impossible for assignment 2.

Evidence that the adapted curriculum improves motivation: the set studying the adapted curriculum had a high proportion completing 1 or more tasks and 2 or more tasks on both open-ended assignments. The scores for tasks 2 and 3 (assignment 1), the best 2 homework scores (assignment 1) and the scores for tasks 1 and 2 (assignment 2) were all higher for the set studying the adapted curriculum.

Evidence* against *the adapted curriculum improving motivation: on the first task in assignment 1, the set studying the adapted curriculum scored lower marks.

Major assessments

The end-of-year mock exam took place in the middle of the research project – after the number topic but before the shape topic.

In this exam, the mean of set 4 is actually higher than set 3 (4.9 compared to 4.7) although the median is higher for set 3 (5 compared to 4.8). This is an indication that set 4 has "closed the gap" with set 3 to an extent. There is no statistical significance.

The first major exam to take place after the completion of the research was in September 2015 (after a 6-week break). Some students had moved set, but the data was extracted from the correct students and assigned to their original sets.

In this exam, set 3 out-performed set 4 with a higher mean (5.0 compared to 3.8) and median (5.2 compared to 3.5). This is statistically significant and shows that set 3 has widened the gap again.

Evidence* against *the adapted curriculum improving motivation: In major exams taking place after the first period of study, the set studying the adapted curriculum had regressed in comparison to the other class. In major exams 9 weeks after all had completed the work, the set studying the* un-adap*ted curriculum had progressed more than the other class.

For this to have more objective validation, these students would have needed to be tracked for a longer period of time (perhaps 6 months prior to the study and a further 6 months afterwards), as well as bench-marking against all students in the year-group within the school or a wider cohort such as using national norms.

The use of an exam the following academic year was clearly not ideal, and the use of this data was not initially planned. It did, however, provide a point a reasonable time period after the study (just as the school assessment in March 2015 provided a data a reasonable time before the study) which allows a long-term pattern to be observed. **It appears that, however much the students in the sets exhibited behaviour which may have indicated better performance as a result of the adapted curriculum, these effects were either temporary in time or limited to the specifics of the topics studied.**

Both the mock exams and the year 11 exam contained material far broader than that studied within this period of research. For the two topics studied to have made an impact more broadly on the entire maths syllabus (and maybe even beyond that) would have required significant changes in motivation leading to a complete change in study habits. If this study were to be repeated, data *on the specific topics which are the subject of the study* should be gathered many months either side of the study. In a school situation this would mean isolating the exam questions involving these topics as well as using the results of the whole exam.

Pupil questionnaires

During topic 1 the attitude of each set was evaluated by questionnaire and interview. The set with the adapted curriculum had a more positive view of the lessons.

During topic 2 the attitude of the set studying the adapted curriculum had a very slightly more positive view of the lessons.

In neither case was this statistically significant.

The data was then evaluated in a different way:

For set 3, the attitude towards the topic studied with the adapted curriculum was far more positive (with statistical significance).

For set 4, the attitude towards the topic studied with the **un-adapted** curriculum was slightly more positive.

Evidence that the adapted curriculum improves motivation: The two sets of results above suggest that, if there is a drop-off in motivation towards the end of term, the adapted curriculum may have reduced this.

A significant confounding variable was the students' under-lying attitude towards school, teachers and the subject. In the interviews it was clear that some students wanted to try and please while others used this as an opportunity to complain about school. It is clear that a group of students in set 3 exhibited a negative group mentality which stretched well beyond the confines of a short classroom project.

In this study, the use of free responses in the student questionnaires was an attempt to validate and perhaps enhance the numerical data collected. Perhaps this was the biggest opportunity lost in this study. Better might have been to create longer and more sophisticated questionnaires which looked at the under-lying attitudes towards personal goals and motivation. It is impossible from the questions given to identify those with a mastery or performance mindset (or whether either of these mindsets has been enhanced), nor whether attribution or self-worth rises over the course of the work. The measurement of self-efficacy is not rigorous. The following might have been more valuable:

- What do you see as the purpose of learning mathematics?
- Is there an area of mathematics you would like to explore in more detail and why?
- Which areas of the syllabus do you feel most confident in?
- Rate your confidence in areas of the syllabus on a scale of 1 to 10.
- Do you feel success in mathematics to be fundamental to success in life and work?

- Are you good at mathematics? Do you think it is possible for you to get better at mathematics and how?

Questionnaires should have been used several weeks / months before the study as well as a long time after the study, in addition to questionnaires linked closely to each of the topics.

Teacher questionnaires

For topic 1, the scores given by the teachers for both of the sets were compared. The set studying the **un-adapted** curriculum was awarded very slightly more positive scores, without statistical significance.

For topic 2, the scores given to the set studying the adapted curriculum was higher with statistical significance.

This may be evidence that the dip in motivation experienced towards the end of term was more pronounced in set 3 (which went from the adapted to the **un-adapted** curriculum) than it was for set 4 (which went the other way).

This data was also analysed the other way:

In set 3 the comparison between the two topics showed no difference.

In set 4 the teacher gave higher scores for most questions during the period studying the adapted curriculum.

There are a number of issues which causes this area of the study to be of limited value:

- These questionnaires provide only anecdotal evidence as they are not based on any kind of rigorous evaluation
- The teachers are aware of the structure of the study and therefore their opinions are not truly independent
- By its nature the questions are subjective
- Questions relating to each set are solely provided by one person (that class's teacher)

Classroom observation

There were two occasions when an observer was able to compare both sets in comparable situations. On both occasions, the researcher was able to move between the two sets while they worked on the same material. On the first occasion (topic 1), set 3 was following the adapted curriculum while on the second occasion (topic 2) set 4 was following it. The following was noted:

- There was good engagement from both classes in the task. No noticeable difference in the two classes.
- In topic 1, set 3 was able to complete the tasks better than set 4. In topic 2, there appeared to be little difference in the class' ability to complete the work.
- In topic 1, set 3 was able to work independently more than set 4. In topic 2, both classes were able to create their designs independently and both were slightly reluctant to move to the research, calculation and tabulation exercise.

- In topic 1, the quality of outcome was better for set 3. In topic 2, the quality of outcome was better for set 4.

Evidence that the adapted curriculum improves motivation: set 3 was able to complete the work better while studying the adapted curriculum whereas the two sets were fairly similar in their ability to complete the work while set 4 studied the adapted curriculum. Similar results apply in the ability to work independently. Since set 3 is the higher ability group, it appears that set 4 studying the adapted curriculum was able to close the gap a little. This result was more notable when considering quality of outcome: in both topics, the quality was better for the set studying the adapted curriculum.

It should be noted that the researcher carried out the lesson observations and was well aware of the aims of the study. Were this to be repeated, a more independent person should be used.

Change of student rank compared to attitude

This area of the study considers individual students, their attitude to the work and their rank within their set. In each case, their rank was considered before the study started (March internal exam), in the middle of the study (mock exam) and after the study (year 11 first exam). This allowed a score to be given identifying change in rank over the first period of study, the second period and overall.

The responses to several of the questions were considered against these scores.

In most cases the results were inconclusive. However, the following was noted:

Student 304: The topic which was seen as more relevant to future life produced the better impact on his results. However, this was not during the period of the adapted curriculum.

Student 309: Topic 1 has not positively influenced this student but he does identify that maths *should* be useful and relevant.

Student 310: There is some evidence here that the student recognised relevance in the work (topic 1) with some improvement in results. This student also gave mixed scores for *how easily could you do the work* and *how good are you at this topic* indicating mixed self-efficacy.

Student 315: This student attained better results on the topic he could see as relevant to future life but did not recognise that work from the lessons.

Student 415: While this student appears to regard the adapted curriculum topics more highly, his results have gone down over this period.

Student 416: This student gave the top grade for *usefulness for life and work* over the period studying the un-adapted curriculum. This student also gave high scores for *how easily could you do the work* and *how good are you at this topic* indicating good self-efficacy. There was a small positive shift in results during this time.

Student 421: This student increased his rank during the period of the adapted curriculum but gave *usefulness for life and work* quite a low score.

The results from students 310 and 416 could indicate that they have recognised the future applicability of their work and their results have risen over the same period. However the number of

students who have shown this correlation is so small (especially as there are others whose results have demonstrated the reverse or no link at all) means that this cannot be generalised.

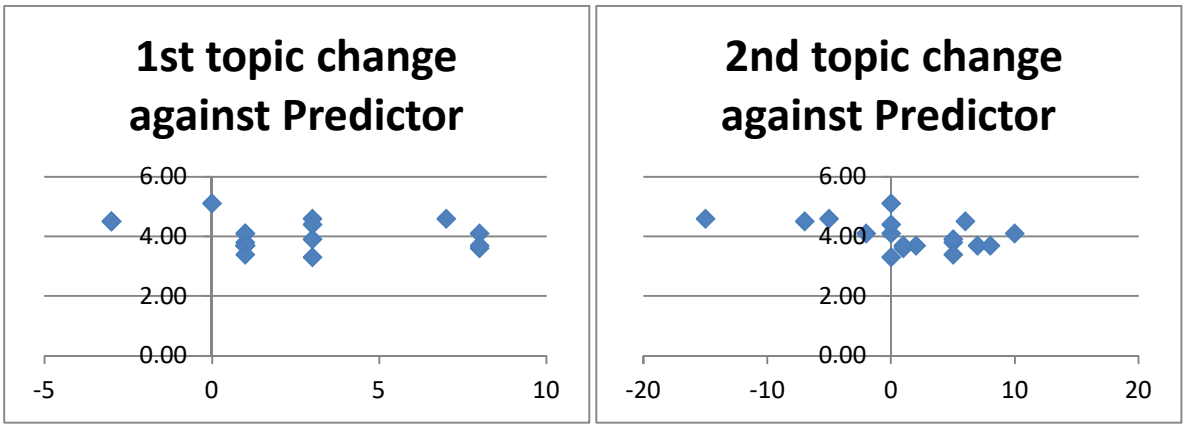
It is clear that there is **insufficient** evidence that significant changes in rank (positive or negative) have been caused by students' perception of the relevance of that material to life and work; furthermore there is no evidence that the adapted curriculum has influenced either the students' opinion or their results.

As indicated above, for future study, more detailed attitudinal surveys, including several which specifically relate to the applicability of the curriculum, should be used.

Changes of rank compared to prior attainment.

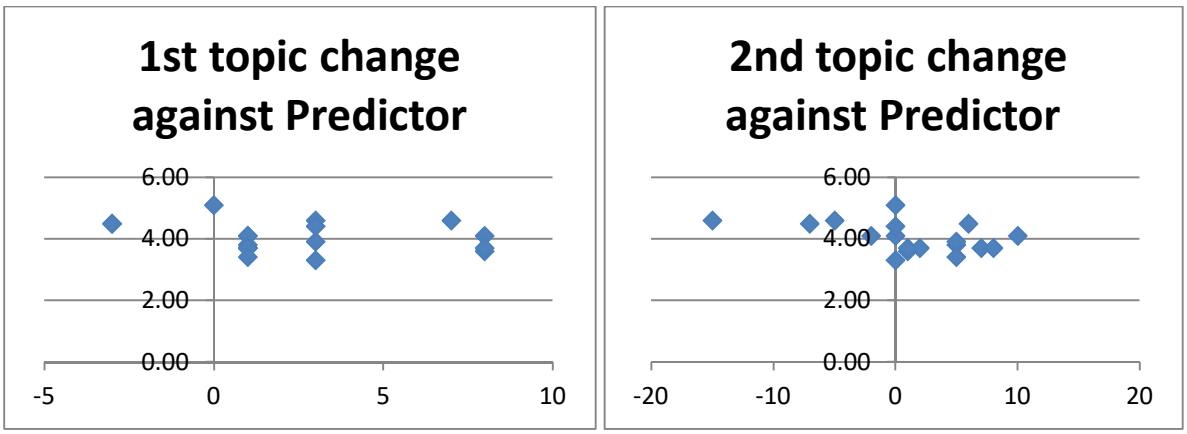
The following scatter graphs plot the changes in rank (as described above) with an objective measure completely independent of this study. The measure used is the GCSE maths predictor, as calculated in March 2015.

Set 3



x-axis is the change in rank for the given topic, y-axis is the maths GCSE predictor

Set 4



As can be seen from the above scatter graphs, there is no discernible correlation between the change in rank and the objective measure of performance. This means that there is no indication that susceptibility to change in performance due to a change in the curriculum is connected to students' long-term academic performance (the GCSE predictor).

Linking these results back to the theory

It is clear from the above that in many respects student performance can be enhanced by adapting the curriculum to demonstrate greater relevance to future life and work. However, from the research conducted it has not been able to verify or disprove existing theories.

Self-efficacy theory – there has not been clear link to self-efficacy theory. There were two questions which indicated self-efficacy – *how easily could you do the work* and *how good are you at this topic* indicating good self-efficacy. There is no discernible link between high scores for these questions and good performance in the work. For future studies, there would need to be a number of questions testing students' self-efficacy both for specific topics and for the subject in general. These factors would need to be evaluated on several occasions before, during and after the study in order to gain a more accurate picture.

Goal theory – on a number of occasions the value of the study for future life and work led to an improvement in academic performance. The responses to the questionnaires, in four cases, suggested that this link had provided motivation and this could be regarded as a performance goal, although it was not explicitly described as such. Further studies, with more sophisticated student questioning, would help to establish this.

These results do support some of Brophy's findings (2007) as they call attention to the instrumental value of activities, induce task interest and use task-related thinking and problem solving. It is also clear that the students in this study did regard some of their work as relevant to the world outside (hence supporting Blumenfeld's work from 1992). Other parts of the work were regarded as useful both for future work and future life (in much the same way as Brophy's "personal relevance"). These findings also resonate with Toumlin (1972) and Pintrich et al (1993) who speak about the use of skills and knowledge in the community and in real-world problems.

Gaps

As stated earlier, there are no existing studies which directly address the question of motivation being provided by classroom curricula relevant to future life and work; there are links between student motivation and usefulness and relevance, but these are general. This study has, to an extent, explored this area and found some initial conclusions.

What has not been done is to create a proper link to the motivation and goals of each student specifically. For this to happen, more detailed attitudinal questioning over an extended period of time would be needed, ideally with a bigger control group, in order to understand further the connections and maybe to establish whether these links to goals are proven.

What is also needed is to explore the extent to which motivation to achieve better results can be more generalised. This study has produced some very specific results: when the results are extended to a broader exam (even in the same subject), the effects are mostly removed.

Future study could:

1. Focus on a single class more closely, giving groups *within the class* different tasks or experiences. This would allow many of the confounding variables regarding teachers and under-lying attitudes to be removed.

2. Broaden the study to include an entire year-group. This would allow for control groups which had no intervention at all. This would require careful setting up in order to ensure that equivalent tasks were being measured. There is no reason why this should be restricted to a single subject – in fact maths, with its ability setting, makes this task harder.

Returning to the Aims of the Study

1 Does a specific link to work-place and real-life skills lead to better engagement in mathematics, more time being spent on task and consequently better results?

As described above, there is evidence that the specific link between a topic of school-work in maths and its broader application **does** improve results on a number of measures. However, these measures do **not** include long-term success in this subject as a whole.

2 Are certain types of student more susceptible to these strategies?

Within the limited scope of this study, there did not appear to be groups of students who were more or less susceptible to this change in the curriculum. The study considered students grouped by:

- an objective measure of student' ability in this subject
- the students who had found the work most and least relevant (as given by responses to surveys)
- those who had high or low self-efficacy (given by responses to surveys)

In none of these cases could a pattern be discerned between change in performance and the student grouping. A number of other groups (SEN, EAL, deprivation etc) had numbers too small to be statistically useful.

3 Does learning linked specifically to skills for the work-place and real life tend to lead to a change in mindset, and is it a performance or a mastery mindset? How can this mindset be measured?

This question has not been answered in this study. For valuable answers, there would need to be a greater sophistication in the student questioning and interviewing in order to identify under-lying goals and motivations over an extended period of time.

4 Have academy schools used the curriculum freedoms open to them to introduce motivational aspects to their teaching such as work-place learning?

This is a question for a future piece of research.

Follow-up study

There are several directions which the follow-up study could follow, in two broad categories.

1 Factors impacting on student motivation
2 The flexibility in curriculum and methodology utilised by schools

For the first, possible lines of enquiry could be:

- The strategies and personality of the teacher

- Personalising learning
- Independent (student-directed) learning

This would need to follow traditional research methods, working with groups in schools, changing the curriculum, the methodology of teaching and the teacher. Long-term data of student performance would be needed. Existing theories on motivation would be used to create better student questionnaires.

For the second, the ways in which schools have used the freedoms available to them to adapt their curricula and methodologies in order to improve motivation could be considered. Academy schools and, to a greater extent, independent schools have some freedoms, and a valuable follow-up might be to survey the ways in which these freedoms have been exploited and what the results have been.

Initially this might be a desk-based piece of research, looking at examples both in the UK and abroad and comparing ways in which innovations have been used.

Two possible surveys are suggested:

- A basic survey of whether such freedoms have been used, what this looks like in practice, and what the results have been. It would be the intention to cast the net quite widely and secure a large number of responses.
- A more in-depth analysis of schools which have been innovative in their approach in order to investigate more fully what has been done. This research could take the form of a series of case studies without gathering further empirical data.

APPENDICES

I Work plan and resources

This was the plan for the research with the two classes:

	Monday	Tuesday	Wednesday	Thursday	Friday
w/b 1st June	Preparation			Number 1	Number 2
w/b 8th June	Number 3	Number 4	Number 5		Number 6
w/b 15th June	Number 7			Number 8	Number 9
w/b 22nd June	Shape 1	Shape 2	Revision		Revision
w/b 29th June	Year 10 exams				
w/b 6th July	Shape 3	Shape 4	Shape 5		Shape 6
w/b 13th July	Shape 7			Shape 8	Shape 9
w/b 20th July	Follow-up	Follow-up	Follow-up		Follow-up

There are 8 weeks in the second half of the autumn term. There are 7 year 10 lessons a fortnight on a fortnightly cycle.

We need a few days to prepare and some days at the end for interviews. Exams fall in the middle of this period, along with some revision.

This leaves a total of 18 possible lessons. This will be 9 lessons for each topic, with the last one being a winding-up.

Topic 1: NUMBER		
	Set 3	Set 4
Lesson 1	Introduction to the project, permission sheet. What are percentages? Think of different uses in the real world Where percentages are seen in the real world Use of maths in the real world	Introduction to the project, permission sheet What are percentages? Connection between percentages, fractions and decimals Exercise to practise the conversions
Lesson 2	Finding a percentage of an amount entirely based on real work situations One quantity as a percentage of another entirely based on real work situations	Finding a percentage of an amount One quantity as a percentage of another Use of diagrams etc
Lesson 3	Percentage increase, Percentage decrease	Percentage increase, Percentage decrease
Lesson 4	Application of percentages: tax, tips, commission, sales increase, proportions in food, repeated increase Open-ended homework	Application of percentages: calculating proportions, increases Open-ended homework
Lesson 5	Discussion of how maths affects business lives Fractions – reminder of basic skills Think of different uses in the real world	Fractions – reminder of basic skills Four functions and fractions of an amount in a theoretical context

	Four functions and fractions of an amount in a real-life context	
Lesson 6	Four functions and fractions of an amount in a real-life context	Four functions and fractions of an amount in a theoretical context
Lesson 7	Ratio and proportion Dividing in ratio – real-life contexts	Ratio and proportion Dividing in ratio – theoretical contexts
Lesson 8	Direct, indirect and other proportions – real-life contexts Closed-ended HW	Direct, indirect and other proportions – theoretical context Closed-ended HW
Lesson 9	Short test Questionnaire and review of work	Short test Questionnaire and review of work

Topic 2: SHAPE		
	Set 3	Set 4
Lesson 1	Areas of basic shapes	Application of this topic in the real world Areas of basic shapes
Lesson 2	Areas of circles, sectors, rings	Areas of circles, sectors, rings in the real world
Lesson 3	Volumes of shapes	Volumes of shapes in a practical context
Lesson 4	Basic introduction to trigonometry The basic rules Practice using SIN	Basic introduction to trigonometry Use in the real world The basic rules Practice using SIN – real-life examples
Lesson 5	COS and TAN	COS and TAN – real-life examples
Lesson 6	Mixed examples of SIN COS TAN Open-ended homework	Mixed examples of SIN COS TAN using real-world examples Open-ended homework
Lesson 7	Constructions introduction and practice	Constructions introduction and practice – real-world examples
Lesson 8	Locus Closed-ended HW	Locus – real-world examples Closed-ended HW
Lesson 9	Short test Questionnaire and review of work	Short test Questionnaire and review of work

In the event, the teachers needed more time for revision and some lessons from the second period of work were lost to that. In addition, at the end of the summer term some additional events find their way onto the calendar. That happened in this case, and as a result more maths lessons were lost. This meant that, of the nine lessons planned for the second period of work, only six took place.

The tables below give the full detail of work covered:

Topic 1: NUMBER		
	Set 3	Set 4
Lesson 1 Thu 4 Jun	Introduction to the project, permission sheet. 15 mins	
	What are percentages? Percentage intro video Real-world use of maths – video	What are percentages? Percentage intro video https://www.youtube.com/watch?v=Hxh0tsCva8E

	Brainstorm on uses of percentages in the real world What does percentage mean? Quantity out of 100 Link between fractions, decimals and percentage RESOURCE 2 (Screen) and 3 (worksheet)	 What does percentage mean? RESOURCE 4: Screen showing percentage as a diagram. Oral exercise identifying percentages Connection between percentages, fractions and decimals RESOURCE 2 (Screen) and 3 (worksheet)
Lesson 2 Fri 5 Jun	Class covered by MAB Continue RESOURCE 2 Real-world use of maths - video How to find one quantity as a percentage of another: RESOURCE 5 Exercises based on real-work situations: RESOURCE 6 How to find a percentage of quantity Real-life exercises: RESOURCES 5 and 6 (continued) Video on uses of percentage	 Continue RESOURCE 2 Video more intro to percent 10 mins How to find one quantity as a percentage of another: RESOURCE 5 Exercises – simple: RESOURCE 7 How to find a percentage of quantity Simple exercises: RESOURCES 5 and 7 (continued)
Lesson 3 Mon 8 Jun	Finding a percentage of a quantity Continue RESOURCE 6 Run through how useful these percentage calculations are in real life. Percentage increase and decrease RESOURCE 8 explains how to do it. Practical applications of increase and decrease percentages Exercise: RESOURCE 9	Finding a percentage of a quantity Continue RESOURCE 7 Percentage increase and decrease RESOURCE 8 explains how to do it. Exercise: RESOURCE 10
Lesson 4 Tue 9 Jun	Continue RESOURCE 9 Practical application of percentages: tax, tips, commission, sales increase, proportions in food, repeated increase	Continue RESOURCE 10 Application of percentages: calculating proportions, increases
Lesson 5 Wed 10 Jun	Bite-size BBC revision of percentage techniques Open ended task (choose 2 out of 3) to complete on the computer RESOURCE 11	Bite-size BBC revision of percentage techniques Open ended task (choose 2 out of 3) to complete on the computer RESOURCE 11
Lesson 6 Fri 12 Jun	Continue with the tasks in computer room Open-ended homework – finish tasks	Continue with the tasks in computer room Open-ended homework – finish tasks
Lesson 7 Mon 15 Jun	Discussion of how maths affects business lives Fractions – reminder of basic skills Cancelling Multiplying fractions together Multiplying fractions and numbers	 Fractions – reminder of basic skills Cancelling Multiplying fractions together Multiplying fractions and numbers

	Fractions questions based on real-world RESOURCE 13 Ratio and proportion Dividing in ratio – practical application RESOURCE 13 Collect in homework (preferably online)	Fractions questions RESOURCE 12 Ratio and proportion Dividing in ratio – theoretical contexts RESOURCE 12 Collect in homework (preferably online)
Lesson 8 Thu 18 Jun	Complete the work on dividing in ratios Direct proportion RESOURCE 14 Exercise: RESOURCE 15 – real-life contexts	Complete the work on dividing in ratios Direct proportions RESOURCE 14 Exercise: RESOURCE 16 – theoretical context
Lesson 9 Fri 19 Jun	Short test Questionnaire and review of work	Short test Questionnaire and review of work

There was then a week of revision followed by internal exams. Topic 2 followed.

Topic 2: SHAPE		
	Set 3	Set 4
Lesson 1 Mon 6 Jul	Areas and perimeters of basic shapes Recap rectangles, triangles, parallelograms, kites, circles Video about area Formulae: RESOURCE 18 Exercise: RESOURCE 19 Squares, rectangles, triangles, trapeziums, parallelograms	Video Brainstorm the possible professions which use these calculations RESOURCE 17 Recap rectangles, triangles, parallelograms, kites, circles Video about area Formulae: RESOURCE 18 Short exercise: RESOURCE 20 involving squares, rectangles, triangles, trapeziums, parallelograms Compound shapes using rectangles
Lesson 2 Tue 7 Jul	Compound shapes: RESOURCE 19, continued	Application of this topic in the real world - measurements in a house: RESOURCE 21
Lesson 3 Wed 8 Jul	Open-ended task.	Open-ended task.
Lesson 4 Fri 10 Jul (OFSTED)	Pythagoras' Theorem Recap the basic rules of Pythagoras Application in a range of triangles, theoretical exercise: RESOURCE 22	Pythagoras' Theorem Recap the basic rules of Pythagoras Application in a range of triangles based on real-life situations: RESOURCE 23
Lesson 5 Thu 16 Jul	Open ended task, continue	Open ended task, continue
Lesson 6 Fri 17 Jul	One revision task (un-adapted), assessment, questionnaire	One revision task (adapted), assessment, questionnaire

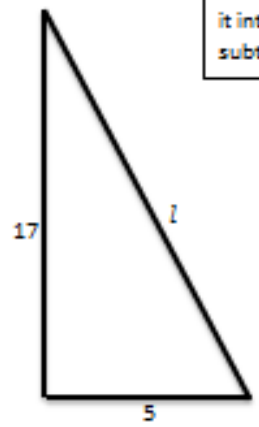
Example of a task in topic 2, un-adapted (resource 24)

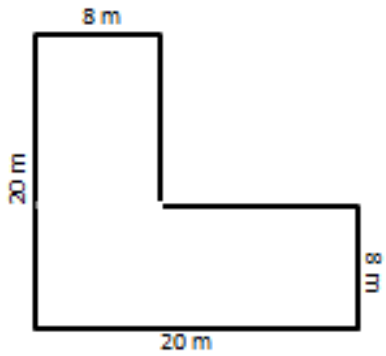
Revision: Area and Pythagoras

Name: Maths set: 3

1

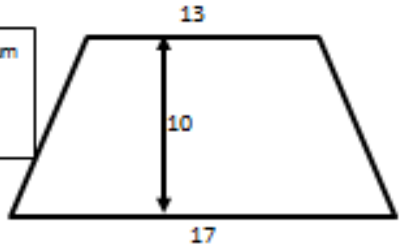
Note: With a compound shape, split it into simpler shapes then add or subtract.





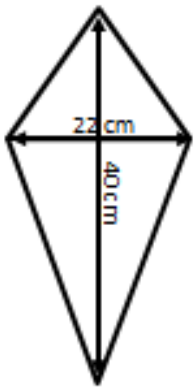
Area of a trapezium

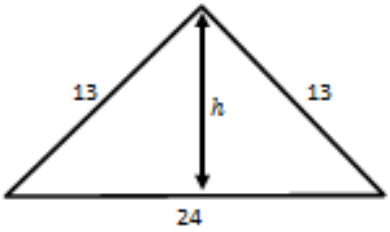
$= \frac{1}{2}(a+b)h$



Area of a kite

$= \frac{1}{2} \times w \times h$

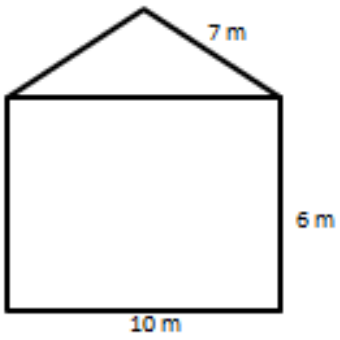




Hint: Divide the top triangle into half, use Pythagoras to find its height

Area of $\triangle$

$= \frac{1}{2} \times b \times h$



Example of a task in topic 2, adapted (resource 25)

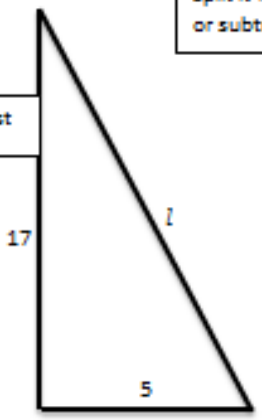
Revision: Area and Pythagoras

Name: Maths set: 4

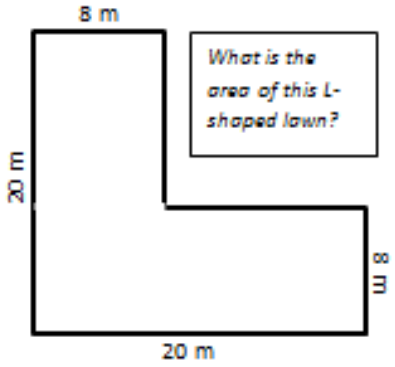
Note: With a compound shape, split it into simpler shapes then add or subtract.

I

Telegraph mast



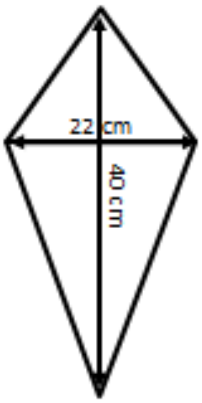
What length of cable is required to secure the top of the mast to the ground 5m from its base?



What is the area of this L-shaped lawn?

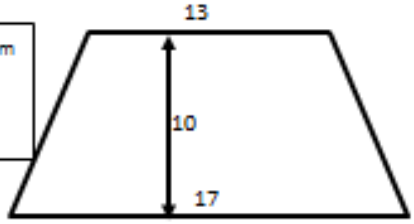
Area of a kite

$$=\frac{1}{2}\times w\times h$$

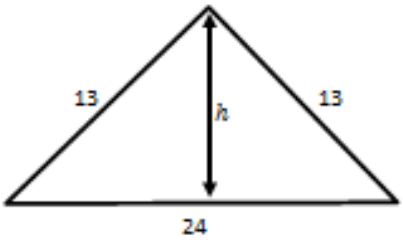


Area of a trapezium

$$=\frac{1}{2}(a+b)h$$



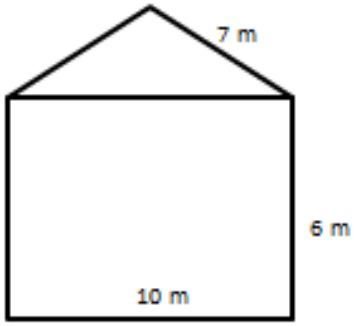
This wooden roof truss is in the shape of a trapezium. What is its area?



Hint: Divide the top triangle into half, use Pythagoras to find its height

Area of $\triangle$

$$=\frac{1}{2}\times b\times h$$



The side elevation of a house is shown. What is its area?

Open-ended task 1: Number (resource 11)

ALCOHOLIC DRINKS

Imagine you are a doctor advising patients on the safe quantity of alcohol which they can consume.

It is recommended that men drink no more than 4 units of alcohol (each unit is 10 ml) and women no more than 3 units per day.

Choose 5 different drinks. Find out the alcoholic content of each drink. Calculate the amount of that drink it is safe to consume. You can find out what measures each drink is served in so you could convert your answers into "number of drinks".

These web-sites might be useful:

http://www.nhs.uk/Livewell/alcohol/Pages/alcohol-units.aspx

http://www.alcoholcontents.com/

	Bottle size	**Alcohol percent**	**Alcohol volume**	**Maximum drinks (man)**	**Maximum drinks (woman)**
Normal lager	500 ml	5%	(0.05 × 500ml) = 25 ml	4 × 10 ÷ 25 = 2 (round down)	3 × 10 ÷ 25 = 1 (round down)

RESTAURANT

Task 1: You are a restaurant owner

Create a menu either by collecting one from a restaurant / take-away or by looking on-line. By each item there needs to be a price. If you eat in, you need to add VAT at 20% to the cost – so give two prices (eat in and take-away).

Task 2: You are a diner

Find a new menu online or in real life; Choose a meal to eat in, calculate its cost and finally add on service at 10%. Show your full working.

FOOD NUTRIENTS

You are considering the amount of nutrition in various foods. Google "nutrition facts" and then a type of manufactured food eg corn flakes. Look at the tables of nutrients, etc: each one has a recommended daily amount.

This is an example from a pack of corn flakes. If we consider the mineral IRON you can see that this serving of cornflakes provides 23% of the daily recommended intake.

Nutrition Facts

Serving Size: 1 box, single serving (.75 oz)

Amount Per Serving	
Calories 76	Calories from Fat 0
	% Daily Value*
Total Fat 0.02 g	**0%**
Saturated Fat 0 g	**0%**
Trans Fat	
Cholesterol 0 mg	**0%**
Sodium 199.29 mg	**8%**
Potassium 24.57 mg	**1%**
Total Carbohydrate 18.21 g	**6%**
Dietary Fiber 0.95 g	**4%**
Sugars 1.37 g	
Sugar Alcohols	
Protein 1.41 g	
Vitamin A 563.01 IU	11%
Vitamin C 0 mg	0%
Calcium 0.63 mg	0%
Iron 4.05 mg	23%

	Corn-flakes					**TOTAL**
Sodium	8%					
Potassium						
Fibre						
Vitamin A	11%					
Vitamin B						
Vitamin C	0%					
Vitamin D						
Calcium	0%					
Iron	23%					
Protein						

Choose a number of other foods and fill in the table to create a day's diet which gives the recommended intake for as many nutrients as possible. You may, of course, include more than one portion of a given food, if you feel that this would be a good diet.

Extra question: if you were **only** getting your vitamin A from corn flakes, how many portions of corn flakes would need to get the required amount of vitamin A?

Instructions

1 Go to the website below.

http://www.theplancollection.com/house-plans/

Explore the plans of some of the houses you like the look of. Look carefully at their plans (VIEW PLAN). Notice that measurements are in feet not metres (approx. 3 ft = 1 m).

2 Your task: design a flat, bungalow or single-storey house. Label each room, identify clearly windows and doors. Write all the dimensions of the rooms, walls, etc.

3 Decide what floor surfaces you want for each room. Check out the prices on these websites.

http://www.diy.com/departments/flooring-tiling/DIY764939.cat

https://www.carpetright.co.uk/carpets

4 Produce a table with the following headings: Room, Area (m2), Floor Surface, Cost /m2, Total cost. Work out a total cost of flooring for the whole flat / house.

Include your plan, fully labelled, in your submission.

You have today's lesson, along with homework.

Save task on FRONTER by **Monday 13th July.**

Flooring Design Project

Name:

Room name	Area (m^2)	Floor surface	Cost per m^2	Total cost

Assessment 1: Number

PERCENTAGES, FRACTIONS, RATIO

Name:	Set:

1 Complete the following table

Fraction	Decimal	Percentage
$^{7}/_{8}$		
	0·6	
		13 %
	2·03	

2 a) What percentage is 4 of 32?

b) What percentage is 15 cm of 75 cm?

c) Find 30% of £1500

d) Find 150% of 80 g

3 a) What do you **multiply** by to achieve an increase of 15%?

b) What do you **multiply** by to achieve a decrease of 8·5%?

4 a) Increase 800 by 11%

b) Decrease 140 kg by 25%

5 a) A shop cuts the price of a £125 coat by 10%. What does it now cost?

b) What is £30·54 + VAT at 15% ?

6 a) $\frac{2}{7} \times \frac{3}{2}$ b) $2\frac{1}{2} \times \frac{5}{4}$

7 a) $\frac{15}{16} \div \frac{7}{8}$ b) $1\frac{1}{2} \div \frac{1}{4}$

8 Simplify a) 14 : 56 b) 15 : 35 : 40

9 Divide in the ratio 32 in the ratio 1 : 3 : 4

10 x is directly proportional to y x is 10 when y is 45

a) What is y when x is 25?

b) What is x when y is 9?

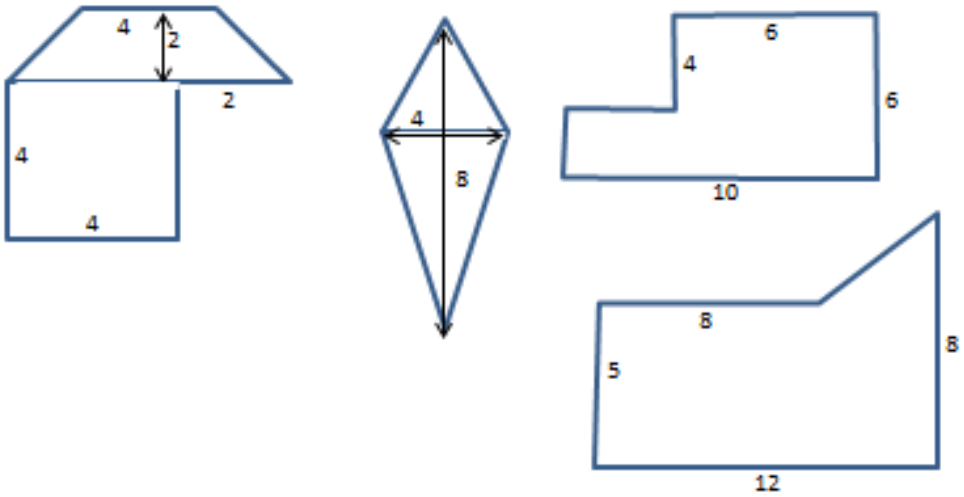
Assessment 2: Shape

AREA OF SHAPES, PYTHAGORAS

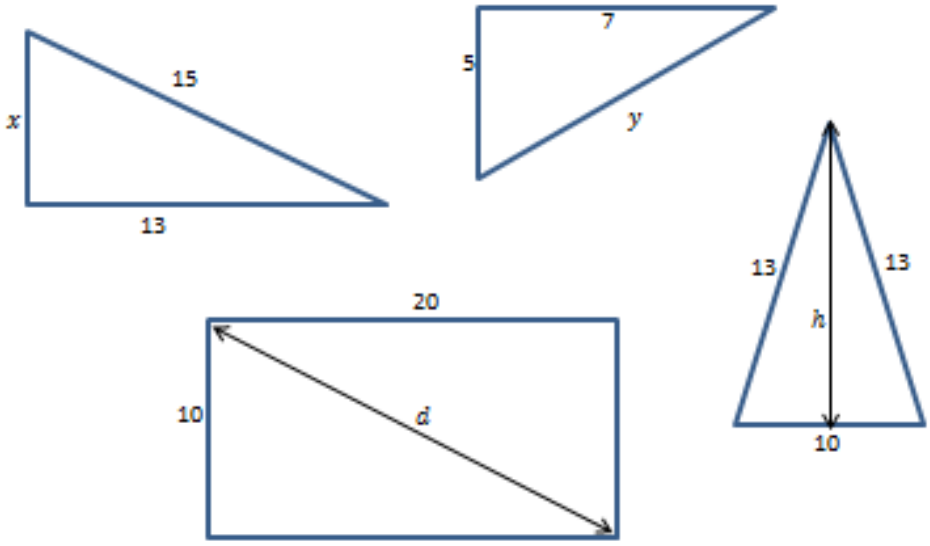
Assessment

Name: Set:

1 Calculate the areas of the following shapes:



2 Calculate the lengths



II Data sheets

				Attendance																			
				June									July						9		6	
Set	code number	Gender	Consent	4	5	8	9	10	12	15	18	19	6	7	8	10	16	17	Attend period 1 number	Attend period 1 percent	Attend period 2 number	Attend period 2 percent
3	301	M	y	/	/	N	/	/	/	/	/	/	/	/	/	/	/	/	8	88.9%	6	100.0%
3	302	M	y	/	/	/	/	/	/	/	/	L	/	L	/	/	/	N	9	100.0%	5	83.3%
3	303	M	y	/	/	/	I	/	/	/	/	/	/	/	/	/	/	/	8	88.9%	6	100.0%
3	304	F	y	C	/	/	/	/	/	/	L	L	/	L	/	I	/	/	8	88.9%	5	83.3%
3	305	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
3	306	F	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
3	307	F		N	/	G	G	G	G	G	G	G	/	L	/	/	/	N	1	11.1%	5	83.3%
3	308	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
3	309	M	y	/	/	/	M	I	/	/	/	/	/	/	/	/	/	N	7	77.8%	5	83.3%
3	310	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
3	311	F	y	I	/	/	I	/	/	/	/	/	/	/	/	/	/	/	7	77.8%	6	100.0%
3	312	M	y	/	/	/	/	/	/	/	P	I	/	/	/	/	/	/	7	77.8%	6	100.0%
3	313	F	y	/	/	/	/	/	/	/	/	/	/	I	I	I	B	N	9	100.0%	1	16.7%
3	315	M	y	/	/	/	/	/	/	/	P	/	/	/	/	/	/	/	8	88.9%	6	100.0%
3	316	M	y	/	/	/	/	/	/	/	/	/	O	/	/	/	-	/	9	100.0%	4	66.7%
3	317	M	y	/	/	/	/	/	/	/	P	/	I	/	V	/	-	/	8	88.9%	3	50.0%
3	318	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
3	320	M	y	/	/	/	/	/	/	N	/	N	L	/	/	/	-	/	7	77.8%	5	83.3%
3	321	M	y	/	/	/	/	/	/	/	/	N	/	/	N	/	-	R	8	88.9%	3	50.0%
3	322	M	y	/	/	/	/	/	/	/	/	N	/	/	N	/	-	R	8	88.9%	3	50.0%
		5																				
		15																				
																			7.9		5.0	
																			87%		83%	
4	401	M	y	/	/	/	L	/	/	/	P	/	/	/	/	/	/	/	8	88.9%	6	100.0%
4	402	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	R	9	100.0%	5	83.3%
4	403	F	y	/	I	/	/	/	/	/	/	N	/	/	/	/	/	R	7	77.8%	5	83.3%
4	404	M	y	/	/	/	/	/	/	/	/	/	/	/	V	/	/	I	9	100.0%	4	66.7%
4	405	M	y	/	/	/	/	/	/	/	/	N	/	/	/	/	/	/	8	88.9%	6	100.0%
4	406	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	407	F	y	/	N	/	/	/	/	/	/	/	/	/	/	/	/	/	8	88.9%	6	100.0%
4	409	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	410	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	411	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	412	F	y	/	/	/	/	N	/	/	/	N	/	/	V	/	M	/	7	77.8%	4	66.7%
4	414	M	y	/	/	/	/	/	/	/	/	/	/	/	I	/	/	/	9	100.0%	5	83.3%
4	415	F	y	/	/	/	/	/	/	I	/	/	/	/	/	/	/	R	8	88.9%	5	83.3%
4	416	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	417	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	418	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	419	F	y	/	/	/	/	/	/	/	/	N	/	/	I	/	/	/	8	88.9%	5	83.3%
4	420	M	y	/	/	/	/	/	/	/	/	/	/	/	/	/	/	/	9	100.0%	6	100.0%
4	421	M	y	I	/	M	/	/	/	/	M	/	/	/	/	/	/	/	6	66.7%	6	100.0%
4	422	F	y	□	□	□	□	□	□	/	/	/	/	/	/	/	/	/	3	33.3%	6	100.0%
		6																				
		14																				
																			8.1		5.6	
																			90%		93%	

									att	cor						att	cor
			10	10	10			20	27	27		10	10			8	8
			Drinks	Menus	Nutrition							Plan	Calculation				
Set	code number	HV 1 complete	HV 1	HV 1	HV 1	Completed 1 HV t	Completed 2 HV t	best 2 HV	Assessment Numl	Assessment Numl	HV 2 complete	HV 2	HV 2	Completed 1 HV t	Completed 2 HV t	Assessment shape	Assessment shape
3	301	hard	5		8	Y	Y	13	17	10	X						
3	302	X						0	7	5	X						
3	303	fronter	3			Y		3			X					4	2
3	304	fronter jo	10		10	Y	Y	20	15	6	X					7	3
3	305	fronter	10	7		Y	Y	17	26	9	X					7	0
3	306	fronter jo	10		10	Y	Y	20	17	11	X					8	0
3	307	X						0				5		Y			
3	308	hard	10		9	Y	Y	19	19	7	X					2	0
3	309	X						0	23	10	X						
3	310	X						0	19	8	X					7	1
3	311	fronter	7		7	Y	Y	14	14	4	X					4	2
3	312	X						0			X					3	3
3	313	fronter	7		9	Y	Y	16	24	22	X						
3	315	fronter	10	6		Y	Y	16	15	7	X					3	2
3	316	X						0	5	2	X					3	0
3	317	X						0	25	12	X					7	4
3	318	X						0	22	15	X					4	2
3	320	hard	10		7	Y	Y	17			X						
3	321	fronter	8	6		Y	Y	14			X						
3	322	fronter	9	6		Y	Y	15			X						
		complete	12	4	7	12	11					1	0	1	0		
			60%	20%	35%	60%	55%					5%	0%	5%	0%		
			8.3	6.3	8.6			9.2	17.7	9.1		5.0	#DIV/0!			4.9	1.6
			83%	63%	86%			46%	66%	34%		50%	#DIV/0!			61%	20%
4	401	X						0	21	13	X						
4	402	hard	10		9	Y	Y	19	3	2	X						
4	403	X						0				7		Y			
4	404	hard	10		5	Y	Y	15	9	7	X						
4	405	X						0				8	7	Y	Y		
4	406	fronter	10	5		Y	Y	15	20	5		8	7	Y	Y	7	6
4	407	hard	10		8	Y	Y	18	10	4		8		Y		1	1
4	409	X						0	15	6	hard	5	7	Y	Y	0	0
4	410	X						0	19	9		4	5	Y	Y	7	5
4	411	hard joint	10		9	Y	Y	19	8	4	X					6	5
4	412	X						0			X					2	1
4	414	X						0	16	9		3		Y		3	1
4	415	X						0	6	1	X					6	5
4	416	fronter	10	4	9	Y	Y	19	21	12		4	5	Y	Y	4	3
4	417	hard joint	10		9	Y	Y	19	8	5	X					6	5
4	418	fronter	8			Y		8	19	6	X					0	0
4	419	hard	10	3	7	Y	Y	17			X					8	4
4	420	X						0	13	5	X					0	0
4	421	X						0	16	3	X						
4	422							0	20	13		7		Y		8	6
		complete	9	3	7	9	8							9	5		
			45%	15%	35%	45%	40%							45%	25%		
			9.8	4.0	8.0			7.5	14.0	6.5		6.0	6.2			4.1	3.0
			98%	40%	80%			37%	52%	24%		60%	62%			52%	38%

Set	code number	Gender	FSM	Ethnicity	SEN Status	EAL	Pupil Premium Indicator	Yellis Band	English Test Level KS2	MathsTest Level KS2	Verbal	Non -Verbal	Maths Assessment 12	GCSE Predictions Ma	Summer mock 2015	Autumn assess 2015
3	301	M	N	White - English	N			B	4	3	110	72	C	6.10	5.2	5.5
3	302	M	N	Turkish			Y	C	4	4	88	96	U	4.50	3.2	4.8
3	303	M	N	White - English	N			C	3	4	88	109	U	4.30	3.2	4.5
3	304	F	N	Black Caribbean				C	5	4			D	5.10	3.8	5.2
3	305	M	N	White Eastern European				D	5	4	83	92	C	3.40	5.2	5.2
3	306	F	Y	White - English	N		Y	C	4	4	116	103	D	4.70	4.8	4.8
3	307	F	N	White - English			Y	C	5	5	104	114	C	4.90	4.8	4.8
3	308	M	N	Other Arian		Y		C					D	5.10	4.8	
3	309	M	N	White - English	N			C	4	4	86	97	C	5.00	5.2	4.2
3	310	M	N	White - English				B	4	4	110	113	D	6.00	5.2	4.8
3	311	F	N	Greek				D	3	3	73	97	U	3.60	3.5	3.5
3	312	M	N	Greek Cypriot	N			C	4	5	86	118	C	4.20	5.2	5.2
3	313	F	N	Iranian			Y	D					B	3.10	6.2	6.2
3	315	M	N	White - English	N			C	4	4	77	105	D	4.60	5.2	5.5
3	316	M	N	White - English	N			D	4	4	92	92	D	4.10	3.5	4.5
3	317	M	N	White - English	N			C	4	4	100	107	C	4.50	5.2	5.2
3	318	M	N	Albanian		Y		B			92	95	D	5.50	4.2	5.2
3	320	M	N	White - English			Y	C					D	4.30	4.8	4.8
3	321	M	N	Turkish		Y		D					B	3.10	5.2	5.5
3	322	M	N	Turkish		Y		C					C	4.60	5.8	5.5
		75%				20%	25%				93.2	100.7		4.5	4.7	5.0
4	401	M	N	Black - Nigerian				C	4	4	108	70	C	5.10	5.8	5.2
4	402	M	N	Moroccan	N	Y		D	3	4	75	101	C	3.70	5.2	4.5
4	403	F	N	White - English				C	4	4			D	4.60	4.5	3.5
4	404	M	N	White - English				D	4	4	94	103	C	3.70	5.2	3.8
4	405	M	N	White - English			Y	D	4	4	104	55	E	4.10	3.8	2.8
4	406	M	N	White - English	N			D	4	3	102	101	C	4.10	5.2	4.8
4	407	F	N	White - English			Y	D	4	4	86	85	C	3.60	4.8	3.5
4	409	M	N	Turkish		Y	Y	D	3	4	85	99	C	3.70	5.2	4.5
4	410	M	N	White - English	N			D	4	3	90	97	C	3.80	5.2	4.2
4	411	M	N	Greek Cypriot									D	4.50	4.8	3.2
4	412	F	Y	White - English	N		Y	D	4	4	102	86	C	4.10	4.8	2.5
4	414	M	N	White - English	N			D	4	4	79	118	C	3.70	4.8	3.5
4	415	F	N	Karavan	N	Y		D	4	4			C	3.70	5.2	3.5
4	416	M	N	White - English	N			C	4	4	96	103	D	4.50	4.8	4.8
4	417	M	N	Turkish Cypriot	N		Y	D	4	3	98	99	D	3.90	4.5	2.2
4	418	M	N	White - English	N		Y	D	4	4	110	99	D	3.30	4.5	3.2
4	419	F	N	White - English	N			D	4	4	75	96	C	3.40	5.2	4.2
4	420	M	N	Turkish			Y	C	4	4	100	92	D	4.40	4.5	3.2
4	421	M	N	White - English	N		Y	C	4	4	88	112	D	4.60	4.2	4.5
4	422	F													4.8	3.5
		70%				15%	40%				93.3	94.8		4.0	4.9	3.8

				Questionnaire 1							Questionnaire 2							
Set	code number		How interesting was this topic?	How well taught was this topic?	How easily could you do the work within this topic?	How useful will this topic be for future life and work?	How well have you developed specific skills in this topic?	How much do you enjoy learning maths?	How good do feel you are at this topic?	very=4	How interesting was this topic?	How well taught was this topic?	How easily could you do the work within this topic?	How useful will this topic be for future life and work?	How well have you developed specific skills in this topic?	How much do you enjoy learning maths?	How good do feel you are at this topic?	very=4
3	301		2	4	3	2	2	1	2		3	3	2	3	3	3	2	
3	302		1	2	2	2	2	1	2		1	1	1	1	1	1	1	
3	303										1	1	1	1	1	1	1	
3	304		1	1	3	4	3	1	1		3	1	3		2	1	3	
3	305		3	4	3	4	4	4	3		2	4	3	2	2	3	3	
3	306		3	4	3	4	4	3	4		3	1	4	2	2	3	4	
3	307																	
3	308		3	3	4	1	4	1	3		1	3	4	2	3	1	2	
3	309		3	3	3	2	3	3	3		2	3	2	3	3	3	3	
3	310		2	3	3	2	2	1	2		1	3	1	2	2	1	2	
3	311		4	4	1	4	4	3	4		3	3	3	4	3	4	3	
3	312										3	3	3	3	3	4	3	
3	313		4	4	3	4	3	4	4									
3	315		2	1	3	2	2	1	1		1	1	1	1	1	1	1	
3	316		1	3	3	3	3	1	2		2	3	2	4	2	2	2	
3	317		3	4	3	4	4	1	3		2	3	3	2	1	2	2	
3	318		2	4	2	3	3	2	2		4	4	3	3	3	2	2	
3	320																	
3	321										2		4	4	3	4	3	
3	322		4	4	4	4	4	4	2		4	4	4	4	3	4	4	
		F	3.0	3.3	2.5	4.0	3.5	2.8	3.3		3.0	1.7	3.3	3.0	2.3	2.7	3.3	
		M	2.4	3.2	3.0	2.6	3.0	1.8	2.3		2.1	2.8	2.4	2.5	2.2	2.3	2.2	
		Both	2.5	3.2	2.9	3.0	3.1	2.1	2.5		2.2	2.6	2.6	2.6	2.2	2.4	2.4	
4	401										2	3	3	4	3	3	3	
4	402		2	3	3	3	3	4	2									
4	403										2	3	2	1	2	3	2	
4	404		3	4	3	4	2	3	3									
4	405										1	3	2	2	2	1	2	
4	406		3	4	2	3	2	2	2		2	3	3	1	2	2	4	
4	407		3	4	2	4	2	3	2		3	4	2	3	3	2	2	
4	409		2	3	2	2	3	2	2		2	3	3	3	3	3	3	
4	410		3	2	3	2	2	3	3		3	3	3	2	2	2	2	
4	411		2	2	2	3	2	3	2		2	3	2	2		3	4	
4	412		3	3	3	4	3	2	2		3	4	2	2	2	3	2	
4	414		2	3	3	1	3	2	2		1	3	3	1	2	1	3	
4	415		3	4	3	2	3	2	3		3	3	3	3	3	3	3	
4	416		3	3	3	4	3	3	3		3	2	3	3	4	3	3	
4	417		3	3	2	3	2	1	1		2	3	3	3	3	2	3	
4	418		2	3	2	1	2	3	2		1	2	2	3	2	2	2	
4	419										2	2	2	2	2	1	3	
4	420		3	2	1	4	2	2	1		1	2	1	3	2	1	1	
4	421		1	3	2	2	2	1	1		2	3	3	2	2	2	2	
4	422		4	4	3			4	3		3	2	2	4	3	4	2	
		F	3.3	3.7	2.7	4.0	2.5	3.0	2.3		2.7	3.0	2.2	2.5	2.5	2.7	2.3	
		M	2.4	2.9	2.3	2.7	2.3	2.4	2.0		1.8	2.8	2.6	2.4	2.5	2.1	2.7	
		Both	2.6	3.1	2.4	2.8	2.4	2.5	2.1		2.1	2.8	2.4	2.4	2.5	2.3	2.6	

Set	code number	Previous maths grade	rank	Summer mock 2015	rank	Autumn assess 2015	rank	1st topic chage	2nd topic change	overall change
3	301	5.00	3	5.2	3	5.5	2	0	-1	-1
3	302	0.00	18	3.2	19	4.8	11	1	-8	-7
3	303	0.00	18	3.2	19	4.5	16	1	-3	-2
3	304	4.00	10	3.8	16	5.2	6	6	-10	-4
3	305	5.00	3	5.2	3	5.2	6	0	3	3
3	306	4.00	10	4.8	11	4.8	11	1	0	1
3	307	5.00	3	4.8	11	4.8	11	8	0	8
3	308	4.00	10	4.8	11			1		
3	309	5.00	3	5.2	3	4.2	18	0	15	15
3	310	4.00	10	5.2	3	4.8	11	-7	8	1
3	311	0.00	18	3.5	17	3.5	19	-1	2	1
3	312	5.00	3	5.2	3	5.2	6	0	3	3
3	313	6.00	1	6.2	1	6.2	1	0	0	0
3	315	4.00	10	5.2	3	5.5	2	-7	-1	-8
3	316	4.00	10	3.5	17	4.5	16	7	-1	6
3	317	5.00	3	5.2	3	5.2	6	0	3	3
3	318	4.00	10	4.2	15	5.2	6	5	-9	-4
3	320	4.00	10	4.8	11	4.8	11	1	0	1
3	321	6.00	1	5.2	3	5.5	2	2	-1	1
3	322	5.00	3	5.8	2	5.5	2	-1	0	-1
				4.7		5.0				
4	401	5.00	1	5.8	1	5.2	1	0	0	0
4	402	5.00	1	5.2	2	4.5	4	1	2	3
4	403	4.00	12	4.5	15	3.5	10	3	-5	-2
4	404	5.00	1	5.2	2	3.8	9	1	7	8
4	405	3.00	19	3.8	20	2.8	18	1	-2	-1
4	406	5.00	1	5.2	2	4.8	2	1	0	1
4	407	5.00	1	4.8	9	3.5	10	8	1	9
4	409	5.00	1	5.2	2	4.5	4	1		
4	410	5.00	1	5.2	2	4.2	7	1	5	6
4	411	4.00	12	4.8	9	3.2	15	-3	6	3
4	412	5.00	1	4.8	9	2.5	19	8	10	18
4	414	5.00	1	4.8	9	3.5	10	8	1	9
4	415	5.00	1	5.2	2	3.5	10	1	8	9
4	416	4.00	12	4.8	9	4.8	2	-3	-7	-10
4	417	4.00	12	4.5	15	2.2	20	3	5	8
4	418	4.00	12	4.5	15	3.2	15	3	0	3
4	419	5.00	1	5.2	2	4.2	7	1	5	6
4	420	4.00	12	4.5	15	3.2	15	3	0	3
4	421	4.00	12	4.2	19	4.5	4	7	-15	-8
4	422			4.8	9	3.5	10		1	
		4.53		4.9		3.8				

Questionnaire for Pupils

As part of our research study into the effectiveness of curriculum and teaching, we would like you to answer the following questions about the recent topic – **Percentages, fraction and ratio** studied **since half term in May.**

Please think carefully and rate the following questions on this 4-point scale:

		Very	Quite	A bit	Not
How interesting was this topic?				X	
How well taught was this topic?			X		
How easily could you do the work within this topic?			X		
How useful will this topic be for future life and work?				X	
How well have you developed specific skills in this topic?				X	
How much do you enjoy learning maths?					X
How good do feel you are at this topic?				X	

For each of these questions, please write between two and four sentences for your answers:

What was the most interesting aspect of this topic?

learning the vat because we will need it in the future

What do you think was the most useful aspect of this topic?

learning about the Bill we will need

How do you feel this topic may help you in your future life?

For paying bills

Name: [redacted] Class: 10X3

NB Your data will be used in order to evaluate the curriculum and teaching methodology. It will be anonymised so that no information will leave the school which can be personally identified with you.

Questionnaire for Teachers

As part of our research study into the effectiveness of curriculum and teaching, we would like you to answer the following questions about the **Percentages, Fractions, Ratio topics, studied between 4th and 19th June.**

Please think carefully and rate the following questions on this 4-point scale:

		Very	Quite	A bit	Not
How interesting do you think students found this topic?					
How well do you think you taught this topic?					
How easily could the students do the work in this topic?					
How useful will this topic be for the students' future life and work?					
How well have they developed specific skills in this topic?					
How much did you enjoy teaching this topic?					
How good was the quality of the students' work in this topic?					
How good was the quantity of the students' work in this topic?					
How good was the students' engagement in this topic?					
How good was the students' attitude in this topic?					
How pleased were you with the amount of work covered in this topic?					

For each of these questions, please write between two and four sentences for your answers:

Which aspect of this topic do you think interested the students most?

What do you think was the most useful aspect of this topic?

How do you feel this topic may help the students' in future life?

Which students do you think benefitted most from this topic?

Any other comments

Name: _____ Class: _____

NB. Data from you and your pupils will be used in order to evaluate the curriculum and teaching methodology. It will be anonymised so that no information will leave the school which can be personally identified with you or any pupil.

In the interviews, I will run through the questionnaire with each student and attempt to flesh out more from the long answers. The interview capture sheet with, therefore, be a bigger version of the questionnaire.

3 July 15

Pupil Interview

Name: [redacted] Class: 10-3

Was there anything unusual about the teaching of these topics?

Change - videos etc. No text books
More fun because of way she taught.
less misbehaviour
Not enjoy maths. Get stuck

What was the most interesting aspect of this topic?

Percentages - Decimals

What do you think was the most useful aspect of this topic?

Real-life situations

How do you feel this topic may help you in your future life?

Maths is useful for life eg mortgages
Useful for exams as well.

I did HW with [redacted]

Comments from pupil questionnaires and interviews

Set 3, Topic 1						
Questionnaire	**Interview**	**Questionnaire**	**Interview**	**Questionnaire**	**Interview**	**Interview**
Most interesting aspect of the topic	**Most interesting aspect of the topic**	**Most useful aspect of the topic**	**Most useful aspect of the topic**	**How it may affect future**	**How it may affect future**	**Was there anything different?**
Easy learning and uncomplicated methods	Nothing in particular, better if more practical	Blank	Clarity of teaching	Blank	Not because not practical Want to be architect	no difference, video made it better because engage. Clear, entertaining,
Fractions and how not get ripped off		Percentages	Find maths pointless, so does everyone, some primary maths useful	Will help with shopping	Wants to be sports journalist	No difference. Better: find an easier way to explain
Blank		Blank		Blank	I did the HW – would be useful	Different work, worksheets, realistic things. Better than normal, I think I did better. I
Percentages because easy and will help in future	New way to do percentages	Percentages		Help in future to sort out salary	Can help in real life eg shops, maths helps in many ways eg	Same way of teaching, Video a good thing
Percentages		How to times percentages		Yes, can calculate percentages		
Nothing	Evereything is boring. Media studies in fun eg filming	Nothing		Nothing	Will not be useful in future work, maybe percentages for income, jobs etc	
Ratio		Percentages	Today's work (shape) could be useful	A little because percentages can be in many jobs	Maths is for real life. Algebra is only use in schools and for exams	No difference in way we learnt. Better would be to do more practical work
Learning VAT because will need it in future		Learning about the bill		For paying bills		
	Decimals and fractions		Fractions		Yes studying business	Improved because revision. Mr Blain helped
	I do like maths		Starter does not help. But collaborative working was useful		Need maths in real life, does prepare you. Angles eg sports, accountancy	More collaborative working eg with partners, worksheets made it easier.
Percentages and answering the questions	Percentage I love maths but others talk to friends	Learning about things that can be useful in future	Have learnt before – just revision	Good	Topics were useful for life and work	Nothing different
Blank	I don't have the patience for normal maths	Blank	How not to get cheated or ripped off	I already know most of this	Percentages, VAT taxes. Parents have taught me	Sheets not text books, about the same quality. More to with real life, can
Nothing		Blank		Blank		
Blank	Percentages decimals	Blank	Real life examples	Percentages	Mortgages in real life, also exams	Chnaged – videos etc, not text books. More fun because of way taught,
Ratios. They were quite easy	Not particularly interesting, more interesting if say how it will be used. I like	Percentages. We use them a lot		Helps me with banking. Also calculate profit	Would not use algebra in everyday life. Percentages yes useful,	A bit easier
	Fraction and percentage. Like to learn using books and tests				It could be eg percentage	No difference. Video was boring

Set 3, Topic 2						
Questionnaire	Interview	Questionnaire	Interview	Questionnaire	Interview	Interview
Most interesting aspect of the topic	**Most interesting aspect of the topic**	**Most useful aspect of the topic**	**Most useful aspect of the topic**	**How it may affect future**	**How it may affect future**	**Was there anything different?**
When I buy a flat I know how to use area to work out flooring /measurements		Area		Area		
None of it	Nothing	None of it	Nothing	It doesn't help	Sports journalism	No. No difference to number topic
Nothing	Ability to check answers	Nothing	nothing. Ratios from the last section were.	It didn't	It could be. Something to do with computing. Probably not useful	No. Couldn't be bothered to do the survey properly. Don't know how compared
Calculating answers	Getting it right	Gonna get me a higher grade in maths		It won't unless I live in a triangle which I highly doubt will occur	Relatable to real life. Wants to be a sports-person	No. This topic was more engaging and more easy to comprehend
Pythagoras		Area of shapes		Won't really help in what I want to do in life		
Calculating answers	Pair work	Learning about calculating answers and to get me a B	"If I lived in a triangle" but I live in a square	I might if I live in a triangle	Not with my career - police	Not unusual. No books, more worksheets - better. This topic easier because
Nothing	Calculating area	Nothing	Calculating area	I t will not. I don't need maths in the future	Maybe	No. Same. Area taught better and was easier
	Pythagoras		Areas		Yes - architecture	No. Percentages better because more useful
I didn't find it interesting	Can't remember	Learning for tests		I don't think it will be helpful	For exam, for house design	No. It was hard. I prefer the number topic because I am better at it; many methods
Blank		Blank		Blank		
	Area		Area		DIY, building, sports (future job). Not really relevant but might need to know this	Nothing. Taught in a similar way, similar difficulty, similar interest
Nothing. I don't find triangles interesting	Project / task	Nothing was useful	Don't like it. Most useful was the project	It may help if I want to do flooring in my house, but I won't have to find x as I can	If you do up your house	No. Not text books. Preferred percentages because I was better at it
					Certain jobs eg carpenter. Need to know how to measure wood etc. Army -	Not really. More individual (percentage was done more in groups). Can't
	Can't remember		Areas		Might do, depending on the job	No. This was harder and I enjoyed it less
	Finding missing lengths				Calculations to do with my house	Nothing. Area was better because easier and more useful
			Area		Maybe for buildings etc. Want to be a pilot. Pythag may be useful but not area	No. Too theoretical. Should have given more application
	Calculating area		All		Business eg building. Not sure my own job. Both life and exams	No. Prefer percentages because videos

Set 4, Topic 1						
Questionnaire	**Interview**	**Questionnaire**	**Interview**	**Questionnaire**	**Interview**	**Interview**
Most interesting aspect of the topic	**Most interesting aspect of the topic**	**Most useful aspect of the topic**	**Most useful aspect of the topic**	**How it may affect future**	**How it may affect future**	**Was there anything different?**
Ratio and proportion	Ratio. Knew it already so enjoyed it	Percentages	Ratio, percentage because in the exam. Decimal multipliers	Purchasing	Percentages might. I want to go into business. Mostly maths for exams, not need in real life	No nothing unusual
Doing the work	I enjoyed it. I like learnng new stuff	Yes it was		Blank	Need maths in real life eg builder. Topic useful for exam and practical life and work	Collaborative - I like this. Tutor said we are taught well
Learning stuff I didn't know before		All of it		Help me pass my exam		
Ratios because easiest		Percentages because they help with discounts		Percentages will help me in shops		
Learning how to do percentages, fractions and ratio		After the lessons I would remember what to do	Helpful fractions because I found it hard	Because they may come up in exams	Exam, childcare	No difference. Open ended task was alright, didn't really appreciate it
How the teacher taught he got the info into my head easily	Video	Percenatges because will help me with my future	Very useful especially this topic	It will help me understand discounts	Depends on job. I want to work in media. Could help if financial area of media	Didn't like the way it was explained. Not clear or as easy to remember. Teaching depends on his mood
Finding out how to do the questions		Learning to do the questions so you have an understanding		Could come up in a test. Know what it means in stores		
Topic wasn't that interesting to me		VAT was useful for some people		Don't think this will help me in future		
	I didn't know it before but now fully understand. Working out ratio					Nothing different
Percentages		Percentages, fractions		Not very much		
I liked ratios since I find it quiet interesting	Ratios	Some of the things we found out had to do with everyday life	Would like both practical work (for jobs) as well as theoretical work (for exams)	Maths will help everyone in their future life, percentages may help with shopping	Did not like the open ended task. Want to be a social worker, probably won't need maths	Practical work but not as good
Percentages		Percentages		It will be helpful with money		
Most of the topics. I liked percentages the most	Percentages - more interesting than usual	That it is useful for statistics for future careers that may have maths work		Can help in business etc	Useful in business, percentages, graphs. Find maths difficult, need to revisit again and again	No. Just normal
Learning and improving how to find percentages	Not really	Blank	Percentages more useful. Build confidence	Blank	Don't think I will use it much. Football coaching - will not need	Done on test papers and worksheets. Videos - useful
Now I could work things out using ratios		Percentages to decimals. I do not know how to convert to percentage	Percentages to decimals. I do not know how to convert to percentage	A lot. Currently revising because it could help in my future life	Banking - might find this useful. Want to study media	No. Normal. Topic was confusing - got distracted
Fraction decimal percentage, hard by I forgot how to do it		Increasing and decreasing percentages		Doubt it will because I want to be a chef unless I own my own company		
Ratio, fractions, equations		Really help me to think and opens my mind	Can't remember	It will help me solve problems and know much about how I will manage	Manage my money, real calculations. Want to be dietician - useful	

Set 4, Topic 2						
Questionnaire	**Interview**	**Questionnaire**	**Interview**	**Questionnaire**	**Interview**	**Interview**
Most interesting aspect of the topic	**Most interesting aspect of the topic**	**Most useful aspect of the topic**	**Most useful aspect of the topic**	**How it may affect future**	**How it may affect future**	**Was there anything different?**
	Getting it right		Learning formulas. More real-life based. Percentages were also real life		Want to be an entrepreneur. Real life examples useful eg plan the area	Nothing unusual. Videos not unusual. Prefer percentages because easier
	Missing lengths				No. Want to own a cake shop or work in a zoo	Nothing unusual. Ask for help wait a long time
					Maybe if designing houses etc	Described it better than the number topic but harder work. More useful than percentages
					Not really in any way	Normal, mainstream. Harder than percentages. This confuses me
The designing work	Dealing with types of shapes	Pythagoras	Pythagoras	With graphics, architecture	Yes - use in graphics, technical drawing. Will be my future career - architecture	Nothing different. Easier than last topic because of material
Learning the topic	Learning	Not sure		I forget how to do it but when reminded I will understand		No. More interesting eg floor plan
I don't find interest	Nothing because I already knew it	I don't know	Easy but can forget. It came straight back to me	I don't think it would	Yes - planning a house. More home than work. What architects do. Want to do media work.	No. Use of videos but not on Pythagoras
The different way Pythagoras can be used	Application	Learning area	Compound area	Blank	I don't think so. Depends on career	No difference. This was easier. I preferred and understood better
Blank		Blank		Blank		
Learning how to do Pythagoras theorem	Pythagoras	Blank	Area - houses etc	Blank	Yes but less than percentages	No. Found percentage and ratio easier
None	None	Finding missing sides	Finding missing sides	None		Nothing unusual, no difference
Making our houses	Areas of multiple shapes	Blank	Being able to work it out	Blank	Yes but not as useful as percentages	Something was different. Prefer it to percentages, understood more
Equations	Because relates to future jobs	Percentage	Doing the graphics	A lot		Nothing unusual. More interesting than the number topic
Blank		Blank		Blank		
Blank		Blank		Blank	Not useful for me	Nothing different. Taught better, more detail but didn't understand
Nothing, it was all the same	Don't know	I don't know	Area	They will not help me as I don't need this topic in the future	Area. Want to be a farmer	Nothing unusual. Found this topic easier than number (personally)
Pythagoras theorem	Did not know Pythagoras but now we do. Something new	Don't know	Exams. In case I become an architect or designer	Blank	May do extra maths	Not much difference. Song on video was catchy. Too much information, may forget. Pythagoras was easier for me
					Don't know. Want to be a chef	Taught fine but I forget. No different to normal. Prefer this because easier
Finding the area of shapes	Area of a house etc	Calculating the area of ground floor plans of a house	Maybe if I wanted to be an architect	It will help if I wan to plan for a house I will get to know the area	All maths is useful in other subjects	It was different, but I am new in the school. Better than the last topic

Comments from teacher questionnaires

Set 3, Topic 1 (adapted curriculum)

Which aspect of this topic do you think interested the students most?	Ease of work very dependent on the student effort and application, all topics have been previously taught this year (hence 2 stars on some answers). % when equated to tax, wages etc.
What do you think was the most useful aspect of this topic?	See above
How do you feel this topic may help the students' in future life?	Basic life skill, ensuring compliance with tax regs and checking interest charges on loans etc. ability to negotiate the market place successfully.
Which students do you think benefitted most from this topic?	Those that were engaged
Any other comments	Difficult to teach using someone else's worksheets, unsure as to what if anything could be changed/added to – not 'my style'. Working on paper devalued the work in some students' eyes.

Set 4, Topic 1 (un-adapted curriculum)

Which aspect of this topic do you think interested the students most?	Most students enjoyed the percentages aspect of the topic most because the methods for calculations were quick and easy to follow especially with a calculator. They enjoyed the challenge of completing the sheet however I am not sure how much of this has been retained due to how quickly they got through it.
What do you think was the most useful aspect of this topic?	Knowing how to quickly work out a percentage of an amount using a simple and straight forward method. Learning how to calculate ratios of amounts is also useful for the pupils.
How do you feel this topic may help the students' in future life?	In a sale or working out interest on a product/payment to check if they are being charged correctly. They can use ratio in knowing how get proportions of amounts correct in cooking and dealing with other solutions.
Which students do you think benefitted most from this topic?	Students who showed retention of the method as they will be able to carry it forward and actually use it in later life. The students who managed to retain will show they have by performing in their tests.
Any other comments	The use of calculators in this topic was heavier than usual for the students and I feel that this may have added to their motivation as it overcame the barrier of poor basic numeracy skills which many of them have.

Set 3, Topic 2 (un-adapted curriculum)

Which aspect of this topic do you think interested the students most?	Area
What do you think was the most useful aspect of this topic?	Area – as more applicable to their idea of a functional maths topic
How do you feel this topic may help the students' in future life?	They can see the application possibilities
Which students do you think benefited most from this topic?	All
Any other comments	

Set 4, Topic 2 (adapted curriculum)

Which aspect of this topic do you think interested the students most?	I think that most students found the area and perimeter topic in which they had to create a floor plan for their 'dream home' most interesting. For the associated homework the hand in numbers were lower than the hand ins for the initial control work (Study one) however, I feel this was more due to the high number of students absent due to it being the last week of term and the general more laid back attitude amongst students (and teachers) at this time. I also think that students enjoyed being able to personalise their work and make it their own design. This is something which we do not often consider as a way of engaging students in mathematics but seeing how the students responded showed me the value of allowing students to be creative in mathematics and how it can help them learn and engage.
What do you think was the most useful aspect of this topic?	Learning how calculate the area and perimeter of compound shapes and calculate the costs of fittings as a result.
How do you feel this topic may help the students' in future life?	They may use this to make their own estimates in gardening and furnishing which can save them money and time. They will also benefit from this topic for the Functional skills questions at GCSE.
Which students do you think benefited most from this topic?	403, who really showed a passion for a maths I haven't seen before in him/her. This was due to him/her being able to apply his/her GCSE Graphics skills in a cross curricular way. Nearly all other students worked at a much higher level of motivation than they normally do and visibly enjoyed working on the project.
Any other comments	I feel that the students benefited and enjoyed being able to use ICT for this project (designing

	their floor plan on a real 'design a home' website)

IV Kruskal-Wallis test

Hypothesis:

Null hypothesis: Null hypothesis assumes that the samples are from identical populations.

Alternative hypothesis: Alternative hypothesis assumes that the samples come from different populations.

Questions answered:

How do test scores differ between the different grade levels in elementary school?

Does a marketing strategy impact intent to purchase scores among different races?

Procedure:

1. Arrange the data of both samples in a single series in ascending order.
2. Assign rank to them in ascending order. In the case of a repeated value, or a tie, assign ranks to them by averaging their rank position.
3. Then sum up the different ranks, e.g. R_1 R_2 $R_{3...}$, for each of the different groups.
4. To calculate the value, apply the following formula:

$$H = \frac{12}{n(n+1)} \sum \frac{{R_i}^2}{n_i} - 3(n+1)$$

Where,
H = Kruskal-Wallis Test statistic
N = total number of observations in all samples
T_i = Sum of the ranks assigned

The Kruskal-Wallis test statistic is approximately a chi-square distribution, with k-1 degrees of freedom where n_i should be greater than 5. If the calculated value of the Kruskal-Wallis test is less than the critical chi-square value, then the null hypothesis cannot be reject. If the calculated value of Kruskal-Wallis test is greater than the critical chi-square value, then we can reject the null hypothesis and say that the sample comes from a different population.

Assumptions

1. We assume that the samples drawn from the population are random.
2. We also assume that the cases of each group are independent.
3. The measurement scale for should be at least ordinal.

http://www.biostathandbook.com/kruskalwallis.html

https://statistics.laerd.com/spss-tutorials/kruskal-wallis-h-test-using-spss-statistics.php

https://www.statisticssolutions.com/kruskal-wallis-test/

P Values

The P value, or calculated probability, is the probability of finding the observed, or more extreme, results when the **null hypothesis (H_0)** of a study question is true – the definition of 'extreme' depends on how the hypothesis is being tested. P is also described in terms of rejecting **H_0** when it is actually true, however, it is not a direct probability of this state.

The null hypothesis is usually an hypothesis of "no difference" e.g. no difference between blood pressures in group A and group B. Define a null hypothesis for each study question clearly before the start of your study.

The only situation in which you should use a **one sided** P value is when a large change in an unexpected direction would have absolutely no relevance to your study. This situation is unusual; if you are in any doubt then use a **two sided** P value.

The term **significance level (alpha)** is used to refer to a pre-chosen probability and the term "P value" is used to indicate a probability that you calculate after a given study.

The **alternative hypothesis (H_1)** is the opposite of the null hypothesis; in plain language terms this is usually the hypothesis you set out to investigate. For example, question is "is there a significant (not due to chance) difference in blood pressures between groups A and B if we give group A the test drug and group B a sugar pill?" and alternative hypothesis is " there is a difference in blood pressures between groups A and B if we give group A the test drug and group B a sugar pill".

If your P value is less than the chosen significance level then you reject the null hypothesis i.e. accept that your sample gives reasonable evidence to support the alternative hypothesis. It does NOT imply a "meaningful" or "important" difference; that is for you to decide when considering the real-world relevance of your result.

The choice of significance level at which you reject H_0 is arbitrary. Conventionally the 5% (less than 1 in 20 chance of being wrong), 1% and 0.1% ($P < 0.05$, 0.01 and 0.001) levels have been used. These numbers can give a false sense of security.

In the ideal world, we would be able to define a "perfectly" random sample, the most appropriate test and one definitive conclusion. We simply cannot. What we can do is try to optimise all stages of our research to minimise sources of uncertainty. When presenting P values some groups find it helpful to use the asterisk rating system as well as quoting the P value:

$P < 0.05$ *

$P < 0.01$ **

$P < 0.001$

Most authors refer to **statistically significant** as $P < 0.05$ and **statistically highly significant** as $P < 0.001$ (less than one in a thousand chance of being wrong).

The asterisk system avoids the woolly term "significant". Please note, however, that many statisticians do not like the asterisk rating system when it is used without showing P values. As a rule of thumb, if you can quote an exact P value then do. You might also want to refer to a quoted exact P value as an asterisk in text narrative or tables of contrasts elsewhere in a report.

At this point, a word about error. **Type I error** is the false rejection of the null hypothesis and **type II error** is the false acceptance of the null hypothesis. As an aid memoir: think that our cynical society rejects before it accepts.

The significance level (alpha) is the probability of type I error. The power of a test is one minus the probability of type II error (beta). Power should be maximised when selecting statistical methods. If you want to estimate sample sizes then you must understand all of the terms mentioned here.

The following table shows the relationship between power and error in hypothesis testing:

		DECISION
	Accept H_0:	Reject H_0:
TRUTH		
H_0 is true:	**correct decision P**	**type I error P**
	1-alpha	*alpha (significance)*
H_0 is false:	**type II error P**	**correct decision P**
	beta	*1-beta (power)*

H_0 = null hypothesis

P = probability

If you are interested in further details of probability and sampling theory at this point then please refer to one of the general texts listed in the reference section.

You must understand **confidence intervals** if you intend to quote P values in reports and papers. Statistical referees of scientific journals expect authors to quote confidence intervals with greater prominence than P values.

Notes about **Type I error**:

- is the incorrect rejection of the null hypothesis
- maximum probability is set in advance as alpha
- is not affected by sample size as it is set in advance
- increases with the number of tests or end points (i.e. do 20 rejections of H_0 and 1 is likely to be wrongly significant for alpha = 0.05)

Notes about **Type II error**:

- is the incorrect acceptance of the null hypothesis

- probability is beta
- beta depends upon sample size and alpha
- can't be estimated except as a function of the true population effect
- beta gets smaller as the sample size gets larger
- beta gets smaller as the number of tests or end points increases

http://www.socscistatistics.com/pvalues/chidistribution.aspx

http://www.statsdirect.com/help/default.htm#basics/p_values.htm

Column A contains the raw data, with column B indicating which set it is from . Column D gives the rank within the combined population, using the correct process for dealing with ties.

Column G gives the data again, grouped in the two sets, with the rank calculated in column D attached to each piece of data. J19 and J35 are the

Data	Set	Rank
1	4	1
2	3	2.5
2	4	2.5
3	4	4
4	3	6
4	4	6
4	4	6
5	3	9.5
5	4	9.5
5	4	9.5
5	4	9.5
6	3	13
6	4	13
6	4	13
7	3	16
7	3	16
7	4	16
8	3	18
9	3	20
9	4	20
9	4	20
10	3	22.5
10	3	22.5
11	3	24
12	3	25.5
12	4	25.5
13	4	27.5
13	4	27.5
15	3	29
22	3	30

Data	Set	Rank		
2	3	2.5		
4	3	6		
5	3	9.5		
6	3	13		
7	3	16		
8	3	18		
9	3	20		
10	3	22.5		
11	3	24		
12	3	25.5		
13	3	27.5		
15	3	29		
22	3	30	254.5	
1	4	1		
2	4	2.5		
3	4	4		
4	4	6		
5	4	9.5		
6	4	13		
7	4	16		
8	4	18		
9	4	20		
10	4	20		
11	4	20		
12	4	20		
13	4	25.5		
13	4	27.5		
15	4	27.5		
22	4	27.5	210.5	

The numbers of data in each set

set 3	14
set 4	16

30
7395.84
0.0129
93
2.43016

$\sum([R\_i]\_\hat{}2)/n\_i$

$12/(n(n+1))$

$3(n+1)$

$$H = \frac{12}{N(N+1)}\left(\frac{R_1^2}{n_1}+\frac{R_2^2}{n_2}+\cdots+\frac{R_k^2}{n_k}\right)-3(N+1)$$

$$= \frac{12}{30(30+1)}\left(\frac{254.5^2}{14}+\frac{210.5^2}{16}\right)-3(30+1) = 2.43$$

$$H = \frac{12}{N(N+1)}\left(\frac{R_1^2}{n_1}+\frac{R_2^2}{n_2}+\frac{R_3^2}{n_3}+\cdots.\frac{R_k^2}{n_k}\right)-3(N+1)$$

Null hypothesis: **the two sets of data come from populations with the same population medians.**

This value of H, with degree of freedom = 1, gives a **P-value of 0.119** (from Chi-squared tables)

This means that the probability of achieving this variation between the sets (or more extreme variation) is 0.119 or 12%.

Using a significance of 5% (or even 10%) there is **insufficient evidence** for rejecting the null hypothesis. We therefore maintain that there is no variance between the population medians.

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